ASME BOILER AND PRESSURE VESSEL CODE

AN INTERNATIONAL CODE

IX

QUALIFICATION STANDARD FOR WELDING AND BRAZING PROCEDURES, WELDERS, BRAZERS, AND WELDING AND BRAZING OPERATORS

2000 Addenda
July 1, 2000

ASME BOILER AND PRESSURE VESSEL COMMITTEE SUBCOMMITTEE ON WELDING

THE AMERICAN SOCIETY OF MECHANICAL ENGINEERS

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IMPORTANT INFORMATION ON THE 1998 BOILER AND PRESSURE VESSEL CODE ADDENDA DISTRIBUTION SCHEDULE

There is a change in the way the Addenda to the 1998 Edition of the ASME Boiler and Pressure Vessel Code are distributed. The 1998 Edition, published July 1, 1998, incorporates the 1998 Addenda revisions, additions, or deletions. There will be no separate 1998 Addenda issued in a replacement page format. Two additional Addenda to the 1998 Edition, in the form of replacement pages, will be issued on July 1, 1999 and July 1, 2000.

The Summary of Changes published with the 1998 Edition lists and describes the revisions that are part of the 1998 Addenda. These changes are identified with a margin note, **98**, denoting the affected area.

The Addenda for 1999 and 2000 will also have a Summary of Changes and identifiers printed on the replacement pages. The revisions, additions, or deletions will be incorporated directly into the affected pages. It is advisable to retain the title sheets and all replaced pages for reference.

The effective dates for Code Editions and Addenda are described in the Foreword.

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SUMMARY OF CHANGES

Addenda to the 1998 Edition of the Code are issued in the form of replacement pages. Revisions, additions, or deletions are incorporated directly into the affected pages. It is advisable, however, that all replaced pages be retained for reference.

Replace or insert the pages listed. Changes given below are identified on the pages by a margin note, **A00**, placed next to the affected area. Revisions to the 1998 Edition are indicated by **98**, and revisions in the 1999 Addenda are indicated by **A99**. For the listing below, the *Page* references the affected area. A margin note, **A00**, placed next to the heading indicates *Location*. Revisions are listed under *Change*.

Page	*Location*	*Change*
vi, vii	Contents	Updated to reflect A00
xvii–xxvi	Roster	Updated to reflect A00
1–2.1	QW-100	Revised
	QW-100.1	Revised
	QW-102	Second line revised
5–6.1	QW-153.1	First paragraph revised
	QW-153.1.1	Revised
	QW-162.1	Seventh line of first paragraph and fourth line of second paragraph revised
	QW-163	Revised
8, 8.1	QW-191.1	Revised
10, 10.1	QW-197	Added
	QW-198	Added
17	QW-216	Revised
	QW-216.2	Revised
	QW-216.3	Revised
43	QW-264	For QW-402, fourth entry added
52	QW-351	Third paragraph revised
58, 58.1	QW-402.16	First sentence revised
	QW-402.18	Added
70–124	QW/QB-422	Revised
126–128.2	QW-432	Revised in its entirety
131	QW-451.1	Second and third column heads revised
132	QW-451.2	Second and third column heads revised
134	QW-452.1	(1) Under second column, second and third entries revised (2) Note (3) revised (3) Note (9) added
152	QW-462.5(a)	Revised
167.1	QW-464.1	Added
167.2	QW-464.2	Added

Page	*Location*	*Change*
176–182.1	QW/QB-492	(1) Definitions of *coalescence; complete fusion; dwell; electrode, composite; face feed; fusion line; plug weld, spray-fuse; stringer bead; throat, effective (of fillet); throat, theoretical (of fillet); weave bead; weld metal;* and *welding, electrogas (EGW)* revised (2) Definitions of *fusion face; oscillation; overlay; weaving;* and *weld interface* added (3) Definitions of *overlay, weld metal; oxyfuel gas cutting (OFC); pass filler;* and *pass, hot* deleted (4) Definitions of *flux (brazing)* and *flux (welding)* incorporated and read as *flux (welding/brazing)*
182.3, 182.4	Article V	Added
184	QB-102	Second line revised
187	QB-163	Second paragraph revised
	QB-172	Subparagraphs (a), (b), and (c) revised
201, 202	QB-351	Revised
	QB-351.1	Added
	QB-351.2	Added
	QB-352	Deleted
	QB-353	Deleted
	QB-354	Deleted
	QB-355	Deleted
	QB-356	Deleted
	QB-357	Deleted
205	QB-416	Deleted
231	B-101	Last paragraph added
232	QW-482	Revised
236.1	QW-485	Added
237	QB-482	Revised
250	Appendix D	For P-No. 8, Grp. No. 2, SA-358 added
255–257	Appendix D	(1) For P-No. 44, SB-333, SB-335, SB-366, SB-564, SB-619, SB-622, and SB-626 added (2) For P-No. 45, SA-743 and SA-744 deleted (3) For P-No. 45, SB-366, SB-462, and SB-564 added (4) For P-No. 47, SB-366 and SB-564 added
258.1, 258.2	Appendix E	Added

NOTE:
Volume 46 of the Interpretations to Section IX of the ASME Boiler and Pressure Vessel Code follows the last page of this Addenda.

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PART QW WELDING

ARTICLE I
WELDING GENERAL REQUIREMENTS

A00 **QW-100 GENERAL**

Section IX of the ASME Boiler and Pressure Vessel Code relates to the qualification of welders, welding operators, brazers, and brazing operators, and the procedures that they employ in welding and brazing according to the ASME Boiler and Pressure Vessel Code and the ASME B31 Code for Pressure Piping. It is divided into two parts: Part QW gives requirements for welding and Part QB contains requirements for brazing. Other Sections of the Code may specify different requirements than those specified by this Section. Such requirements take precedence over those of this Section, and the manufacturer or contractor shall comply with them.

A00 **QW-100.1** A Welding Procedure Specification (WPS) is a written document that provides direction to the welder or welding operator for making production welds in accordance with Code requirements. Any WPSs used by a manufacturer or contractor that will have responsible operational control of production welding shall be a WPS that has been qualified by that manufacturer or contractor in accordance with Article II, or it shall be an AWS Standard Welding Procedure Specification (SWPS) listed in Appendix E and adopted by that manufacturer or contractor in accordance with Article V.

Both WPSs and SWPSs specify the conditions (including ranges, if any) under which welding must be performed. These conditions include the base metals that are permitted, the filler metals that must be used (if any), preheat and postweld heat treatment requirements, etc. Such conditions are referred to in this Section as welding "variables."

When a WPS is to be prepared by the manufacturer or contractor, it must address, as a minimum, the specific variables, both essential and nonessential, as provided in Article II for each process to be used in production welding. In addition, when other Sections of the Code require notch toughness qualification of the WPS, the applicable supplementary essential variables must be addressed in the WPS.

The purpose for qualification of a WPS is to determine that the weldment proposed for construction is capable of providing the required properties for its intended application. Welding procedure qualification establishes the properties of the weldment, not the skill of the welder or welding operator.

The Procedure Qualification Record (PQR) documents what occurred during welding the test coupon and the results of testing of the coupon. As a minimum, the PQR shall document the essential variables and other specific information identified in Article II for each process used during welding the test coupon and the results of the required testing. In addition, when notch toughness testing is required for procedure qualification, the applicable supplementary essential variables for each process shall be recorded.

QW-100.2 In performance qualification, the basic criterion established for welder qualification is to determine the welder's ability to deposit sound weld metal. The purpose of the performance qualification test for the welding operator is to determine the welding operator's mechanical ability to operate the welding equipment.

QW-100.3 Welding Procedure Specifications (WPS) written and qualified in accordance with the rules of this Section, and welders and welding operators of automatic and machine welding equipment also qualified in accordance with these rules may be used in any construction built to the requirements of the ASME Boiler and Pressure Vessel Code or the ASME B31 Code for Pressure Piping.

However, other Sections of the Code state the conditions under which Section IX requirements are mandatory, in whole or in part, and give additional requirements. The reader is advised to take these provisions into consideration when using this Section.

Welding Procedure Specifications, Procedure Qualification Records, and Welder/Welding Operator Performance Qualification made in accordance with the requirements of the 1962 Edition or any later Edition of Section IX may be used in any construction built to the ASME Boiler and Pressure Vessel Code or the ASME B31 Code for Pressure Piping.

Welding Procedure Specifications, Procedure Qualification Records, and Welder/Welding Operator Performance Qualification made in accordance with the requirements of the Editions of Section IX prior to 1962, in which all of the requirements of the 1962 Edition or later Editions are met, may also be used.

Welding Procedure Specifications and Welder/Welding Operator Performance Qualification records meeting the above requirements do not need to be amended to include any variables required by later Editions and Addenda.

Qualification of new Welding Procedure Specifications or Welders/Welding Operators and requalification of existing Welding Procedure Specifications or Welders/Welding Operators shall be in accordance with the current Edition (see Foreword) and Addenda of Section IX.

QW-101 Scope

The rules in this Section apply to the preparation of Welding Procedure Specifications and the qualification of welding procedures, welders, and welding operators for all types of manual and machine welding processes permitted in this Section. These rules may also be applied, insofar as they are applicable, to other manual or machine welding processes permitted in other Sections.

QW-102 Terms and Definitions

A99 A00

Some of the more common terms relating to welding and brazing are defined in QW/QB-492.

Wherever the word pipe is designated, tube shall also be applicable.

QW-103 Responsibility

QW-103.1 Welding. Each manufacturer[1] or contractor[1] is responsible for the welding done by his organization and shall conduct the tests required in this Section to qualify the welding procedures he uses in the construction of the weldments built under this Code, and the performance of welders and welding operators who apply these procedures.

QW-103.2 Records. Each manufacturer or contractor shall maintain a record of the results obtained in welding procedure and welder and welding operator performance qualifications. These records shall be certified by the manufacturer or contractor and shall be accessible to the Authorized Inspector. Refer to recommended Forms in Nonmandatory Appendix B. A99

QW-110 WELD ORIENTATION

The orientations of welds are illustrated in QW-461.1 or QW-461.2.

QW-120 TEST POSITIONS FOR GROOVE WELDS

Groove welds may be made in test coupons oriented in any of the positions in QW-461.3 or QW-461.4 and as described in the following paragraphs, except that an angular deviation of ±15 deg. from the specified horizontal and vertical planes, and an angular deviation of ±5 deg. from the specified inclined plane are permitted during welding.

QW-121 Plate Positions

QW-121.1 Flat Position 1G. Plate in a horizontal plane with the weld metal deposited from above. Refer to QW-461.3 sketch (a).

QW-121.2 Horizontal Position 2G. Plate in a vertical plane with the axis of the weld horizontal. Refer to QW-461.3 sketch (b).

QW-121.3 Vertical Position 3G. Plate in a vertical plane with the axis of the weld vertical. Refer to QW-461.3 sketch (c).

QW-121.4 Overhead Position 4G. Plate in a horizontal plane with the weld metal deposited from underneath. Refer to QW-461.3 sketch (d).

[1] Wherever these words are used in Section IX, they shall include installer or assembler.

QW-122 Pipe Positions

QW-122.1 Flat Position 1G. Pipe with its axis horizontal and rolled during welding so that the weld metal is deposited from above. Refer to QW-461.4 sketch (a).

QW-122.2 Horizontal Position 2G. Pipe with its axis vertical and the axis of the weld in a horizontal plane. Pipe shall not be rotated during welding. Refer to QW-461.4 sketch (b).

QW-122.3 Multiple Position 5G. Pipe with its axis horizontal and with the welding groove in a vertical plane. Welding shall be done without rotating the pipe. Refer to QW-461.4 sketch (c).

QW-122.4 Multiple Position 6G. Pipe with its axis inclined at 45 deg. to horizontal. Welding shall be done without rotating the pipe. Refer to QW-461.4 sketch (d).

QW-123 Test Positions for Stud Welds

QW-123.1 Stud Welding. Stud welds may be made in test coupons oriented in any of the positions as described in QW-121 for plate and QW-122 for pipe (excluding QW-122.1). In all cases, the stud shall be

QW-153 Acceptance Criteria — Tension Tests

A99 A00 **QW-153.1 Tensile Strength.** Minimum values for procedure qualification are provided under the column heading "Minimum Specified Tensile, ksi" of QW/QB-422. In order to pass the tension test, the specimen shall have a tensile strength that is not less than:

(a) the minimum specified tensile strength of the base metal; or

(b) the minimum specified tensile strength of the weaker of the two, if base metals of different minimum tensile strengths are used; or

(c) the minimum specified tensile strength of the weld metal when the applicable Section provides for the use of weld metal having lower room temperature strength than the base metal;

(d) if the specimen breaks in the base metal outside of the weld or fusion line, the test shall be accepted as meeting the requirements, provided the strength is not more than 5% below the minimum specified tensile strength of the base metal.

A99 A00 **QW-153.1.1 Additional Requirements for Specific Base Metals**

(a) For Aluminum Alclad (P-No. 21 through P-No. 23) materials 0.499 in. and less, the specified minimum tensile strength is for full thickness specimens that include cladding. For Aluminum Alclad materials 0.5 in. and greater, the specified minimum tensile strength is for both full thickness specimens that include cladding and specimens taken from the core.

(b) For copper and copper-based alloys (P-No. 31 through P-No. 35), the minimum specified tensile value provided by QW/QB-422 is that given for the base metal in the annealed condition and is the acceptance value for qualification.

(c) All P-No. 23 minimum specified tensile values, provided by QW/QB-422, are not designated in the respective SB documents and are the acceptance values for qualifications using T4 or T6 temper base metal and tested in the as-welded condition. The other aluminum materials (P-No. 21 through P-No. 25) have minimum specified tensile values using the *O* temper.

(d) For nickel and nickel-based alloys (P-No. 41 through P-No. 47), the minimum specified tensile value provided by QW/QB-422 is that given for the base metal in the annealed condition and is the acceptance value for qualification.

QW-160 GUIDED-BEND TESTS

QW-161 Specimens

Guided-bend test specimens shall be prepared by cutting the test plate or pipe to form specimens of approximately rectangular cross section. The cut surfaces shall be designated the sides of the specimen. The other two surfaces shall be called the face and root surfaces, the face surface having the greater width of weld. The specimen thickness and bend radius are shown in QW-466.1, QW-466.2, and QW-466.3. Guided-bend specimens are of five types, depending on whether the axis of the weld is transverse or parallel to the longitudinal axis of the specimen, and which surface (side, face, or root) is on the convex (outer) side of bent specimen. The five types are defined as follows.

QW-161.1 Transverse Side Bend. The weld is transverse to the longitudinal axis of the specimen, which is bent so that one of the side surfaces becomes the convex surface of the bent specimen. Transverse side-bend test specimens shall conform to the dimensions shown in QW-462.2.

Specimens of base metal thickness over $1\frac{1}{2}$ in. (38 mm) may be cut into approximately equal strips between $\frac{3}{4}$ in. (19 mm) and $1\frac{1}{2}$ in. (38 mm) wide for testing, or the specimens may be bent at full width (see requirements on jig width in QW-466). If multiple specimens are used, one complete set shall be made for each required test. Each specimen shall be tested and meet the requirements in QW-163.

QW-161.2 Transverse Face Bend. The weld is transverse to the longitudinal axis of the specimen, which is bent so that the face surface becomes the convex surface of the bent specimen. Transverse face-bend test specimens shall conform to the dimensions shown in QW-462.3(a). For subsize transverse face bends, see QW-161.4.

QW-161.3 Transverse Root Bend. The weld is transverse to the longitudinal axis of the specimen, which is bent so that the root surface becomes the convex surface of the bent specimen. Transverse root-bend test specimens shall conform to the dimensions shown in QW-462.3(a). For subsize transverse root bends, see QW-161.4.

QW-161.4 Subsize Transverse Face and Root Bends. See Note (2) of QW-462.3(a).

QW-161.5 Longitudinal-Bend Tests. Longitudinal-bend tests may be used in lieu of the transverse side-, face-, and root-bend tests for testing weld metal or base metal combinations which differ markedly in bending properties between

(a) the two base metals; or

(b) the weld metal and the base metal.

QW-161.6 Longitudinal Face Bend. The weld is parallel to the longitudinal axis of the specimen, which is bent so that the face surface becomes the convex surface of the bent specimen. Longitudinal face-bend test specimens shall conform to the dimensions shown in QW-462.3(b).

QW-161.7 Longitudinal Root Bend. The weld is parallel to the longitudinal axis of the specimen, which is bent so that the root surface becomes the convex side of the bent specimen. Longitudinal root-bend test specimens shall conform to the dimensions shown in QW-462.3(b).

QW-162 Guided-Bend Test Procedure

A00 **QW-162.1 Jigs.** Guided-bend specimens shall be bent in test jigs that are in substantial accordance with QW-466. When using the jigs illustrated in QW-466.1 or QW-466.2, the side of the specimen turned toward the gap of the jig shall be the face for face-bend specimens, the root for root-bend specimens, and the side with the greater discontinuities, if any, for side-bend specimens. The specimen shall be forced into the die by applying load on the plunger until the curvature of the specimen is such that a $\frac{1}{8}$ in. (3.2 mm) diameter wire cannot be inserted between the specimen and the die of QW-466.1, or the specimen is bottom ejected if the roller type of jig (QW-466.2) is used.

When using the wrap around jig (QW-466.3), the side of the specimen turned toward the roller shall be the face for face-bend specimens, the root for root-bend specimens, and the side with the greater discontinuities, if any, for side-bend specimens.

When specimens wider than $1\frac{1}{2}$ in. (38 mm) are to be bent as permitted in QW-462.2, the test jig mandrel must be at least $\frac{1}{4}$ in. (6 mm) wider than the specimen width.

A00 QW-163 Acceptance Criteria — Bend Tests

The weld and heat-affected zone of a transverse weld-bend specimen shall be completely within the bent portion of the specimen after testing.

The guided-bend specimens shall have no open discontinuities in the weld or heat-affected zone exceeding $\frac{1}{8}$ in. (3.2 mm), measured in any direction on the convex surface of the specimen after bending. Open discontinuities occurring on the corners of the specimen during testing shall not be considered unless there is definite evidence that they result from lack of fusion, slag inclusions, or other internal discontinuities. For corrosion-resistant weld overlay cladding, no open discontinuity exceeding $\frac{1}{16}$ in. (1.6 mm), measured in any direction, shall be permitted in the cladding, and no open discontinuities exceeding $\frac{1}{8}$ in. (3.2 mm) shall be permitted along the approximate weld interface.

QW-170 NOTCH-TOUGHNESS TESTS

QW-171 Notch-Toughness Tests — Charpy V-Notch

QW-171.1 General. Charpy V-notch impact tests shall be made when required by other Sections.

Test procedures and apparatus shall conform to the requirements of SA-370.

QW-171.2 Acceptance. The acceptance criteria shall be in accordance with that Section specifying impact requirements.

QW-171.3 Location and Orientation of Test Specimen. The impact test specimen and notch location and orientation shall be as given in the Section requiring such tests.

When qualifying pipe in the 5G or 6G position, the notch-toughness specimens shall be removed from the shaded portion of QW-463.1(f).

QW-172 Notch-Toughness Tests — Drop Weight

QW-172.1 General. Drop weight tests shall be made when required by other Sections.

Test procedures and apparatus shall conform to the requirements of ASTM Specification E 208.

QW-172.2 Acceptance. The acceptance criteria shall be in accordance with that Section requiring drop weight tests.

QW-172.3 Location and Orientation of Test Specimen. The drop weight test specimen, the crack starter location, and the orientation shall be as given in the Section requiring such tests.

When qualifying pipe in the 5G or 6G position, the notch-toughness specimens shall be removed from the shaded portion of QW-463.1(f).

QW-180 FILLET-WELD TESTS

QW-181 Procedure and Performance Qualification Specimens

QW-181.1 Procedure. The dimensions and preparation of the fillet-weld test coupon for procedure qualification as required in QW-202 shall conform to the

requirements in QW-462.4(a) or QW-462.4(d). The test coupon for plate-to-plate shall be cut transversely to provide five test specimen sections, each approximately 2 in. (51 mm) long. For pipe-to-plate or pipe-to-pipe, the test coupon shall be cut transversely to provide four approximately equal test specimen sections. The

test specimens shall be macro-examined to the requirements of QW-183.

QW-181.1.1 Production Assembly Mockups. Production assembly mockups may be used in lieu of QW-181.1. The mockups for plate-to-shape shall be cut transversely to provide five approximately equal test specimens not to exceed approximately 2 in. (51 mm) in length. For pipe-to-shape mockups, the mockup shall be cut transversely to provide four approximately equal test specimens. For small mockups, multiple mockups may be required to obtain the required number of test specimens. The test specimens shall be macro-examined to the requirements of QW-183.

QW-181.2 Performance. The dimensions and the preparation of the fillet-weld test coupon for performance qualification shall conform to the requirements in QW-462.4(b) or QW-462.4(c). The test coupon for plate-to-plate shall be cut transversely to provide a center section approximately 4 in. (102 mm) long and two end sections, each approximately 1 in. (25 mm) long. For pipe-to-plate or pipe-to-pipe, the test coupon shall be cut to provide two quarter sections test specimens opposite to each other. One of the test specimens shall be fracture tested in accordance with QW-182 and the other macro-examined to the requirements of QW-184. When qualifying pipe-to-plate or pipe-to-pipe in the 5F position, the test specimens shall be removed as indicated in QW-463.2(h).

QW-181.2.1 Production Assembly Mockups. Production assembly mockups may be used in lieu of the fillet-weld test coupon requirements of QW-181.2.

(a) Plate-to-shape

(1) The mockup for plate-to-shape shall be cut transversely to provide three approximately equal test specimens not to exceed approximately 2 in. (51 mm) in length. The test specimen that contains the start and stop of the weld shall be fracture tested in accordance with QW-182. A cut end of one of the remaining test specimens shall be macro-examined in accordance with QW-184.

(b) Pipe-to-shape

(1) The mockup for pipe-to-shape shall be cut transversely to provide two quarter sections approximately opposite to each other. The test specimen that contains the start and stop of the weld shall be fracture tested in accordance with QW-182. A cut end of the other quarter section shall be macro-examined in accordance with QW-184. When qualifying pipe-to-shape in the 5F position, the fracture specimen shall be removed from the lower 90 deg section of the mockup.

QW-182 Fracture Tests

The stem of the 4 in. performance specimen center section in QW-462.4(b) or the stem of the quarter section in QW-462.4(c), as applicable, shall be loaded laterally in such a way that the root of the weld is in tension. The load shall be steadily increased until the specimen fractures or bends flat upon itself.

If the specimen fractures, the fractured surface shall show no evidence of cracks or incomplete root fusion, and the sum of the lengths of inclusions and porosity visible on the fractured surface shall not exceed $\frac{3}{8}$ in. in QW-462.4(b) or 10% of the quarter section in QW-462.4(c).

QW-183 Macro-Examination — Procedure Specimens

One face of each cross section of the five test specimens in QW-462.4(a) or four test specimens in QW-462.4(d), as applicable shall be smoothed and etched with a suitable etchant (see QW-470) to give a clear definition to the weld metal and heat affected zone. The examination of the cross sections shall include only one side of the test specimen at the area where the plate or pipe is divided into sections i.e., adjacent faces at the cut shall not be used. In order to pass the test:

Visual examination of the cross sections of the weld metal and heat affected zone shall show complete fusion and freedom from cracks; and

There shall not be more than $\frac{1}{8}$ in. (3.2 mm) difference in the length of the legs of the fillet.

QW-184 Macro-Examination — Performance Specimens

The cut end of one of the end plate sections, approximately 1 in. long, in QW-462.4(b) or the cut end of one of the pipe quarter sections in QW-462.4(c), as applicable, shall be smoothed and etched with a suitable etchant (see QW-470) to give a clear definition of the weld metal and heat affected zone. In order to pass the test:

Visual examination of the cross section of the weld metal and heat affected zone shall show complete fusion and freedom from cracks, except that linear indications at the root not exceeding $\frac{1}{32}$ in. (0.8 mm) shall be acceptable; and

The weld shall not have a concavity or convexity greater than $\frac{1}{16}$ in. (1.6 mm); and

There shall be not more than $\frac{1}{8}$ in. (3.2 mm) difference in the lengths of the legs of the fillet.

QW-190 OTHER TESTS AND EXAMINATIONS

QW-191 Radiographic Examination

A00 **QW-191.1 Method.** The radiographic examination in QW-142 for welders and in QW-143 for welding operators shall meet the requirements of Article 2, Section V, except as follows.

(a) A written radiographic examination procedure is not required. Demonstration of density and penetrameter image requirements on production or technique radiographs shall be considered satisfactory evidence of compliance with Article 2 of Section V.

(b) The requirements of T-285 of Article 2 of Section V are to be used only as a guide. Final acceptance of radiographs shall be based on the ability to see the prescribed penetrameter image and the specified hole or the designated wire or a wire penetrameter. The acceptance standards of QW-191.2 shall be met.

QW-191.2 Radiographic Acceptance Criteria

QW-191.2.1 Terminology

Linear Indications. Cracks, incomplete fusion, inadequate penetration, and slag are represented on the radiograph as linear indications in which the length is more than three times the width.

Rounded Indications. Porosity and inclusions such as slag or tungsten are represented on the radiograph as rounded indications with a length three times the width or less. These indications may be circular, elliptical, or irregular in shape; may have tails; and may vary in density.

QW-191.2.2 Acceptance Standards. Welder and welding operator performance tests by radiography of welds in test assemblies shall be judged unacceptable when the radiograph exhibits any imperfections in excess of the limits specified below.

(a) Linear Indications

(1) any type of crack or zone of incomplete fusion or penetration;

(2) any elongated slag inclusion which has a length greater than:

(a) $\frac{1}{8}$ in. for t up to $\frac{3}{8}$ in., inclusive

(b) $\frac{1}{3}t$ for t over $\frac{3}{8}$ to $2\frac{1}{4}$ in., inclusive

(c) $\frac{3}{4}$ in. for t over $2\frac{1}{4}$ in.

(3) any group of slag inclusions in line that have an aggregate length greater than t in a length of $12t$, except when the distance between the successive imperfections exceeds $6L$ where L is the length of the longest imperfection in the group.

(b) Rounded Indications

(1) The maximum permissible dimension for rounded indications shall be 20% of t or $\frac{1}{8}$ in. (3.2 mm), whichever is smaller.

(2) For welds in material less than $\frac{1}{8}$ in. (3.2 mm) in thickness, the maximum number of acceptable rounded indications shall not exceed 12 in a 6 in. (152 mm) length of weld. A proportionately fewer number of rounded indications shall be permitted in welds less than 6 in. (152 mm) in length.

(3) For welds in material $\frac{1}{8}$ in. (3.2 mm) or greater in thickness, the charts in Appendix I represent the maximum acceptable types of rounded indications illustrated in typically clustered, assorted, and randomly dispersed configurations. Rounded indications less than $\frac{1}{32}$ in. (0.8 mm) in maximum diameter shall not be considered in the radiographic acceptance tests of welders and welding operators in these ranges of material thicknesses.

QW-191.2.3 Production Welds. The acceptance standard for welding operators who qualify on production welds shall be that specified in the referencing Code Section. The acceptance standard for welders who qualify on production welds as permitted by QW-304.1 shall be per QW-191.2.2.

QW-191.3 Record of Tests. The results of welder and welding operator performance tests by radiography shall be recorded in accordance with QW-301.4.

QW-192 Stud-Weld Tests — Procedure Qualification Specimens

QW-192.1 Required Tests. Ten stud-weld tests are required to qualify each procedure. The equipment used for stud welding shall be completely automatic except for manual starting.

Every other welding stud (five joints) shall be tested either by hammering over until one-fourth of its length is flat on the test piece, or by bending the stud to an angle of at least 15 deg. and returning it to its original position using a test jig and an adapter location dimension that are in accordance with QW-466.4.

The remaining five welded stud joints shall be tested in torque using a torque testing arrangement that is substantially in accordance with QW-466.5. Alternatively, where torquing is not feasible, tensile testing may be used, and the fixture for tensile testing shall be similar to that shown in QW-466.6 except that studs without heads may be gripped on the unwelded end in the jaws of the tensile testing machine.

QW-192.2 Acceptance Criteria — Bend and Hammer Tests. In order to pass the test(s), each of the five stud welds and heat affected zones shall be free of visible separation or fracture after bending and return bending or after hammering.

QW-192.3 Acceptance Criteria — Torque Tests. In order to pass the test(s), each of the five stud welds shall be subjected to the required torque shown in the following table before failure occurs.

Required Torque for Testing Threaded Carbon Steel Studs

Nominal Diameter of Studs, in.	Threads/in. and Series Designated	Testing Torque, ft-lb
1/4	28 UNF	5.0
1/4	20 UNC	4.2
5/16	24 UNF	9.5
5/16	18 UNC	8.6
3/8	24 UNF	17
3/8	16 UNC	15
7/16	20 UNF	27
7/16	14 UNC	24
1/2	20 UNF	42
1/2	13 UNC	37
9/16	18 UNF	60
9/16	12 UNC	54
5/8	18 UNF	84
5/8	11 UNC	74
3/4	16 UNF	147
3/4	10 UNC	132
7/8	14 UNF	234
7/8	9 UNC	212
1	12 UNF	348
1	8 UNC	318

Required Torque for Testing Threaded Austenitic Stainless Steel Studs

Nominal Diameter of Studs, in.	Threads/in. and Series Designated	Testing Torque, ft-lb
1/4	28 UNF	4.5
1/4	20 UNC	4.0
5/16	24 UNF	9.0
5/16	18 UNC	8.0
3/8	24 UNF	16.5
3/8	16 UNC	14.5
7/16	20 UNF	26.0
7/16	14 UNC	23.0
1/2	20 UNF	40.0
1/2	13 UNC	35.5
5/8	18 UNF	80.00
5/8	11 UNC	71.00
3/4	16 UNF	140.00
3/4	10 UNC	125.00
7/8	14 UNF	223.00
7/8	9 UNC	202.00
1	14 UNF	339.00
1	8 UNC	303.00

Alternatively, where torquing to destruction is not feasible, tensile testing may be used. For carbon and austenitic stainless steel studs, the failure strength shall not be less than 35,000 psi (241 MPa) and 30,000 psi (207 MPa), respectively. For other metals, the failure strength shall not be less than 1/2 of the minimum specified tensile strength of the stud material. The failure strength shall be based on the minor diameter of the threaded section of externally threaded studs except where the shank diameter is less than the minor diameter, or on the original cross-sectional area where failure occurs in a nonthreaded, internally threaded, or reduced-diameter stud.

QW-192.4 Acceptance Criteria — Macro-Examination. In order to pass the macro-examination, each of five sectioned stud welds and the heat affected zone shall be free of cracks when examined at a magnification of ×10, which is required by QW-202.5 when studs are welded to metals other than P-No. 1.

QW-193 Stud-Weld Tests — Performance Qualification Specimens

QW-193.1 Required Tests. Five stud-weld tests are required to qualify each stud-welding operator. The equipment used for stud welding shall be completely automatic except for manual starting. The performance test shall be welded in accordance with a qualified WPS per QW-301.2.

Each stud (five joints) shall be tested either by hammering over until one-fourth of its length is flat on the test piece or by bending the stud to an angle of at least 15 deg. and returning it to its original position using a test jig and an adapter location dimension that are in accordance with QW-466.4.

QW-193.2 Acceptance Criteria — Bend and Hammer Tests. In order to pass the test(s), each of the five stud welds and heat affected zones shall be free of visible separation or fracture after bending and return bending or after hammering.

QW-194 Visual Examination — Performance

Performance test coupons shall show complete joint penetration with complete fusion of weld metal and base metal.

QW-195 Liquid Penetrant Examination

QW-195.1 The liquid penetrant examination in QW-214 for corrosion-resistant weld metal overlay shall meet the requirements of Article 6, Section V. The acceptance standards of QW-195.2 shall be met.

QW-195.2 Liquid Penetrant Acceptance Criteria

QW-195.2.1 Terminology

(a) relevant indications — indications with major dimensions greater than $^1/_{16}$ in. (1.6 mm).

(b) linear indications — an indication having a length greater than three times the width

(c) rounded indications — an indication of circular or elliptical shape with the length equal to or less than three times the width

QW-195.2.2 Acceptance Standards. Procedure and performance tests examined by liquid penetrant techniques shall be judged unacceptable when the examination exhibits any indication in excess of the limits specified below:

(a) relevant linear indications;

(b) relevant rounded indications greater than $^3/_{16}$ in. (4.8 mm);

(c) four or more relevant rounded indications in a line separated by $^1/_{16}$ in. (1.6 mm) or less (edge-to-edge).

QW-196 Resistance Weld Testing

QW-196.1 Metallographic Examination

QW-196.1.1 Welds shall be cross-sectioned, polished, and etched to reveal the weld metal. The section shall be examined at a magnification of 10 times.

QW-196.1.2 The weld nugget shall be sound for 1.25 times the thickness of the thinner member.

QW-196.1.3 For spot welds, the nugget size shall be measured at the interface between the sheets being joined, and it shall equal or exceed $0.9\sqrt{t}$, where t is the thickness of the thinner sheet. For projection welds, the nugget size shall not be less than the initial size of the projection. For seam welds, the width of the fused weld cut transverse to the seam shall be not less than $0.9\sqrt{t}$, where t is the thickness of the thinnest sheet.

QW-196.2 Mechanical Testing

QW-196.2.1 Shear test specimens shall be prepared as shown on QW-462.9. For spot and projection welds, each test specimen shall equal or exceed the minimum strength, and the average strength specified in QW-462.10 and QW-462.11 for the appropriate material. Further, for each set, 90% shall have shear strength values between 0.9 and 1.1 times the set average value. The remaining 10% shall lie between 0.8 and 1.2 times the set average value.

QW-196.2.2 Peel test specimens shall be prepared as shown in QW-462.8. The specimens shall be peeled or separated mechanically, and fracture shall occur in the base metal by tearing out of the weld in order for the specimen to be acceptable.

QW-197 Laser Beam Welding (LBW) Lap Joint Tests — Procedure Qualification Specimens A00

QW-197.1 Required Tests. Six tension shear specimens and eight macro specimens are required to qualify each procedure. The qualification test coupon shall be prepared in accordance with QW-464.1. The tension shear specimens shall conform to the dimensions indicated in the table of QW-464.1. The longitudinal and traverse sections indicated in QW-464.1 shall be cross-sectioned as closely as possible through the centerline of the weld. A minimum of 1 in. shall be provided for examination of each longitudinal specimen. The traverse specimens shall be of sufficient length to include weld, the heat-affected zone, and portions of the unaffected base material. Cross-sections shall be smoothed and etched with a suitable etchant (see QW-470), and examined at a minimum magnification of 25X. The dimensions of the fusion zone and penetration of each weld of the traverse specimens shall be measured to the nearest hundredth of an inch and recorded.

QW-197.2 Acceptance Criteria — Tension Shear Tests. In order to pass the tension shear test(s), the requirements of QW-153 shall apply.

QW-197.3 Acceptance Criteria — Macro-Examination. In order to pass the macro-examination, each of the eight specimens shall meet the following criteria.

(a) The outline of the fusion zone shall be generally consistent in size and regular in shape and uniformity of penetration.

(b) The examination of the weld area shall reveal sound weld metal, complete fusion along the bond line, and complete freedom from cracks in the weld metal and heat-affected zone.

QW-198 Laser Beam Welding (LBW) Lap Joint Tests — Performance Qualification Specimens A00

QW-198.1 Required Tests. A peel test specimen at least 6 in. long shall be prepared as shown in QW-464.2(a) and macro specimens as shown in QW-464.2(b). The peel test specimens shall be peeled apart to destruction and the fusion zone and penetration measured to the nearest hundredth of an inch. The end of each strip of the macro coupon shall be polished and etched to clearly reveal the weld metal. The width and depth of penetration of each weld shall be measured

to the nearest hundredth of an inch. Each specimen shall be examined in accordance with QW-197.1.

QW-198.2 Acceptance Criteria — Peel Test and Macro-Examination. In order to pass the peel test and macro-examination, the dimensions of the fusion zone (averaged) and the penetration (averaged) shall be within the range of dimensions of those specified on the WPS that was used to make the test coupon.

QW-210 PREPARATION OF TEST COUPON

QW-211 Base Metal

The base metals may consist of either plate, pipe, or other product forms. Qualification in plate also qualifies for pipe welding and vice versa. The dimensions of the test coupon shall be sufficient to provide the required test specimens.

QW-212 Type and Dimensions of Groove Welds

Except as otherwise provided in QW-250, the type and dimensions of the welding groove are not essential variables.

QW-213 P-No. 11 Base Metals

For vessels or parts of vessels constructed with P-No. 11 base metals, weld grooves for thickness less than $\frac{5}{8}$ in. (16 mm) shall be prepared by thermal processes, when such processes are to be employed during fabrication. This groove preparation shall also include back gouging, back grooving, or removal of unsound weld metal by thermal processes, when these processes are to be employed during fabrication.

QW-214 Corrosion-Resistant Weld Metal Overlay

QW-214.1 The size of test coupons, limits of qualification, required examinations and tests, and test specimens shall be as specified in QW-453.

QW-214.2 Essential variables shall be as specified in QW-250 for the applicable welding process.

QW-215 Electron Beam Welding and Laser Beam Welding

QW-215.1 The WPS qualification test coupon shall be prepared with the joint geometry duplicating that to be used in production. If the production weld is to include a lap-over (completing the weld by rewelding over the starting area of the weld, as for a girth weld), such lap-over shall be included in the WPS qualification test coupon.

QW-215.2 The mechanical testing requirements of QW-451 shall apply.

QW-215.3 Essential variables shall be as specified in QW-260 and QW-264 for the applicable welding process.

QW-216 Hard-Facing Weld Metal Overlay A00

Hard-Facing Weld Metal Overlay refers to weld deposits made, using a variety of processes, to deter the effects of wear and/or abrasion. The following requirements apply regardless of which hard-facing process is used.

QW-216.1 The size of test coupons, limits of qualification, required examinations and tests, and test specimens shall be as specified in QW-453.

QW-216.2 Welding variables shall be as specified in QW-250 for the applicable process. A00

QW-216.3 Where Spray Fuse methods of hard-facing (e.g., Oxyfuel and Plasma Arc) are to be used, the coupons for these methods shall be prepared and welding variables applied in accordance with QW-216.1 and QW-216.2, respectively. A00

QW-216.4 If a weld deposit is to be used under a hardfacing weld metal overlay, a base metal with an assigned P-Number and a chemical analysis nominally matching the weld deposit chemical analysis may be substituted to qualify the PQR.

QW-217 Joining of Composite (Clad Metals)

The WPS for groove welds in clad metal shall be qualified as provided in (a) below when any part of the cladding thickness, as permitted by the referencing Code Section, is included in the design calculations. Either (a) or (b) below may be used when the cladding thickness is not included in the design calculations.

(a) The essential and nonessential variables of QW-250 shall apply for each welding process used in production. The procedure qualification test coupon shall be made using the same P-Number base metal, cladding, and welding process, and filler metal combination to be used in production welding. For metal not included in QW/QB-422, the metal used in the composite test plate shall be within the range of chemical composition of that to be used in production. The qualified thickness range for the base metal and filler metal(s) shall be based on the actual test coupon thickness for each as applied to QW-451, except that the minimum thickness of filler metal joining the cladding portion of the weldment shall be based on a chemical analysis performed in accordance with QW-453. Tensile and bend tests required in QW-451 for groove welds

shall be made, and they shall contain the full thickness of cladding through the reduced section of the specimen. The bond line between the original cladding and the base metal may be disregarded when evaluating side-bend tests if the cladding was applied by a process other than fusion welding.

(b) The essential and nonessential variables of QW-250 shall apply for each welding process used in production for joining the base metal portion of the weldment. The PQRs that support this portion of the WPS need not be based on test coupons made with clad metal. For the corrosion-resistant overlay portion of the weld, the essential variables of QW-251.4 shall apply and the test coupon and testing shall be in accordance with QW-453. The WPS shall limit the depth of the groove, which will receive the corrosion-resistant overlay in order to ensure development of the full strength of the underlying weld in the base metal.

QW-218 Applied Linings

QW-218.1 WPSs for attaching applied linings shall be qualified in accordance with QW-202.2(a), (b), or (c).

QW-218.2 As an alternative to the above, each process to be used in attaching applied linings to base metal shall be qualified on a test coupon welded into the form and arrangement to be used in construction using materials that are within the range of chemical composition of the metal to be used for the base plate, the lining, and the weld metal. The welding variables of QW-250 shall apply except for those regarding base metal or weld metal thickness. Qualification tests shall be made for each position to be used in production welding in accordance with QW-461.9, except that qualification in the vertical position, uphill progression shall qualify for all positions. One cross section for each position tested shall be sectioned, polished, and etched to clearly show the demarcation between the base metal and the weld metal. In order to be acceptable, each specimen shall exhibit complete fusion of the weld metal with the base metal and freedom from cracks.

QW-218.3 When chemical analysis of the weld deposit for any elements is required, a chemical analysis shall be performed per QW-453, Note 9 for those elements.

QW-250 WELDING VARIABLES

QW-251 General

QW-251.1 Types of Variables for Welding Procedure Specifications (WPS). These variables (listed for each welding process in QW-252 through QW-265) are subdivided into essential variables, supplementary essential variables, and nonessential variables (QW-401). The "Brief of Variables" listed in the Tables are for reference *only*. See the complete variable in Welding Data of Article IV.

QW-251.2 Essential Variables. Essential variables are those in which a change, as described in the specific variables, is considered to affect the mechanical properties of the weldment, and shall require requalification of the WPS.

Supplementary essential variables are required for metals for which other Sections specify notch-toughness tests and are in addition to the essential variables for each welding process.

QW-251.3 Nonessential Variables. Nonessential variables are those in which a change, as described in the specific variables, may be made in the WPS without requalification.

QW-251.4 Special Processes

(a) The special process essential variables for corrosion-resistant and hard-surfacing weld metal overlays are as indicated in the following tables for the specified process. Only the variables specified for special processes shall apply. A change in the corrosion-resistant or hard-surfacing welding process shall require requalification.

(b) WPS qualified for corrosion-resistant and hard-surfacing overlay welding, in accordance with other Sections when such qualification rules were included in those Sections, may be used with the same provisions as provided in QW-100.3.

A00

QW-264
WELDING VARIABLES PROCEDURE SPECIFICATIONS (WPS)
Laser Beam Welding (LBW)

Paragraph		Brief of Variables	Essential	Supplementary Essential	Nonessential
QW-402 Joints	.1	ϕ Groove design	X		
	.2	$\pm$ Backing	X		
	.6	> Fit-up gap	X		
	.18	ϕ Lap joint config.	X		
QW-403 Base Metals	.1	ϕ P-Number	X		
	.3	ϕ Penetration	X		
	.13	ϕ P-No. 5/9/10	X		
	.15	ϕ P-Number	X		
QW-404 Filler Metals	.1	ϕ Cross section or speed	X		
	.2	< *t* or ϕ comp.	X		
	.8	$\pm$ or ϕ Chem. comp.	X		
	.14	$\pm$ Filler	X		
	.20	ϕ Method of addition	X		
	.21	ϕ Analysis	X		
	.33	ϕ AWS class.			X
QW-406 Preheat	.1	Decrease > 100°F	X		
QW-407 PWHT	.1	ϕ PWHT	X		
QW-408 Gas	.2	ϕ Single, mixture, or %	X		
	.6	ϕ Environment	X		
	.11	$\pm$ Gases	X		
	.12	ϕ > 5% Gases	X		
	.13	ϕ Plasma jet position	X		
QW-409 Electrical Characteristics	.19	ϕ Pulse	X		
	.20	ϕ Mode, energy	X		
	.21	ϕ Power, speed, d/fl, distance	X		
QW-410 Technique	.5	ϕ Method cleaning			X
	.7	ϕ Oscillation	X		
	.14	ϕ Angle of beam axis	X		
	.17	ϕ Type equip.	X		
	.20	+ Wash pass	X		
	.21	1 vs. 2 side welding	X		
	.37	ϕ Single to mult. pass	X		

Legend:
+ Addition > Increase/greater than $\uparrow$ Uphill $\leftarrow$ Forehand ϕ Change
– Deletion < Decrease/less than $\downarrow$ Downhill $\rightarrow$ Backhand

QW-264.1
WELDING VARIABLES PROCEDURE SPECIFICATIONS (WPS)
Laser Beam Welding (LBW)

Paragraph		Special Process Essential Variables	
		Hardfacing Overlay (QW-216)	Corrosion-Resistant Overlay (QW-214)
QW-402 Joints	.16	< finished *t*	< finished *t*
QW-403 Base Metals	.13	ϕ P-Number 5/9/10	ϕ P-Number 5/9/10
	.20	ϕ P-Number	ϕ P-Number
QW-404 Filler Metals	.12	ϕ AWS class.	ϕ AWS class.
	.27	ϕ Alloy elements	ϕ Alloy elements
	.44	ϕ Particle type	ϕ Particle type
	.47	ϕ Filler/powder metal size	ϕ Filler/powder metal size
	.48	ϕ Powder metal density	ϕ Powder metal density
	.49	ϕ Filler/powder metal feed rate	ϕ Filler/powder metal feed rate
QW-405 Positions	.1	+ Position	+ Position
QW-406 Preheat	.4	Dec. > 100°F preheat > Interpass	Dec. > 100°F preheat > Interpass
QW-407 PWHT	.6	ϕ PWHT	ϕ PWHT
QW-408 Gas	.2	ϕ Single, mixture, or %	ϕ Single, mixture, or %
	.6	ϕ Environment	ϕ Environment
	.11	$\pm$ Gases	$\pm$ Gases
	.12	ϕ % flow rate	ϕ % flow rate
	.13	ϕ Plasma jet position	ϕ Plasma jet position
QW-409 Electrical Characteristics	.19	ϕ Pulse	ϕ Pulse
	.20	ϕ Mode, energy	ϕ Mode, energy
	.21	ϕ Power, speed, d/fl, distance	ϕ Power speed, d/fl, distance
QW-410 Technique	.7	ϕ Oscillation	ϕ Oscillation
	.14	ϕ Angle of beam axis	ϕ Angle of beam axis
	.17	ϕ Type equip.	ϕ Type equip.
	.38	ϕ Multi- to single-layer	ϕ Multi- to single-layer
	.45	ϕ Method of surface prep.	ϕ Method of surface prep.
	.52	ϕ Filler metal delivery	ϕ Filler metal delivery
	.53	ϕ Overlap, spacing	ϕ Overlap, spacing

Legend:
+ Addition > Increase/greater than ϕ Change
– Deletion < Decrease/less than

QW-320 RETESTS AND RENEWAL OF QUALIFICATION

QW-321 Retests

A welder or welding operator who fails one or more of the tests prescribed in QW-304 or QW-305, as applicable, may be retested under the following conditions.

QW-321.1 Immediate Retest Using Visual Examination. When the qualification coupon has failed the visual examination of QW-302.4, retesting shall be by visual examination before conducting the mechanical testing.

When an immediate retest is made, the welder or welding operator shall make two consecutive test coupons for each position which he has failed, all of which shall pass the visual examination requirements.

The examiner may select one of the successful test coupons from each set of retest coupons which pass the visual examination for conducting the mechanical testing.

QW-321.2 Immediate Retest Using Mechanical Testing. When the qualification coupon has failed the mechanical testing of QW-302.1, retesting shall be by mechanical testing.

When an immediate retest is made, the welder or welding operator shall make two consecutive test coupons for each position which he has failed, all of which shall pass the test requirements.

QW-321.3 Immediate Retest Using Radiography. When the qualification coupon has failed the radiographic examination of QW-302.2, the immediate retest shall be by the radiographic examination method.

(a) For welders and welding operators the retest shall be to radiographically examine two 6 in. (152 mm) plate coupons; for pipe, to examine two pipes for a total of 12 in. (305 mm) of weld, which shall include the entire weld circumference for pipe or pipes (for small diameter pipe the total number of consecutively made test coupons need not exceed eight).

(b) At the option of the manufacturer, the welder who has failed the (production weld alternative) test in QW-304.1 may be retested by radiographing an additional 12 in. (305 mm) length of the same production weld. If this length of weld passes the test, the welder is qualified and the area of weld on which he had previously failed the test shall be repaired by him or another qualified welder.

If this 12 in. (305 mm) length does not meet the radiographic standards, the welder has failed the retest and all of the production welds made by this welder shall be radiographed completely and repaired by a qualified welder or welding operator.

(c) At the option of the manufacturer, the welding operator who has failed the test in QW-305.2 may be retested by radiographing an additional 6 ft (1.8 m) length of the same production weld. If this length of weld passes the test, the welding operator is qualified and the area of weld on which he had previously failed the test shall be repaired by him or another qualified welder or welding operator. If this 6 ft (1.8 m) length does not meet the radiographic standards, the welding operator has failed the retest and all of the production welds made by this welding operator shall be radiographed completely and repaired by a qualified welder or welding operator.

QW-321.4 Further Training. When the welder or the welding operator has had further training or practice, a new test shall be made for each position on which he failed to meet the requirements.

QW-322 Expiration and Renewal of Qualification

QW-322.1 Expiration of Qualification. The performance qualification of a welder or welding operator shall be affected when one of the following conditions occurs:

(a) When he has not welded with a process during a period of 6 months or more, his qualifications for that process shall expire; unless, within the six month period, prior to his expiration of qualification,

(1) a welder has welded using a manual or semiautomatic welding process which will maintain his qualification for manual and semiautomatic welding with that process;

(2) a welding operator has welded with a machine or automatic welding process which will maintain his qualification for machine and automatic welding with that process.

(b) When there is a specific reason to question his ability to make welds that meet the specification, the qualifications which support the welding he is doing shall be revoked. All other qualifications not questioned remain in effect.

QW-322.2 Renewal of Qualification

(a) Renewal of qualification expired under QW-322.1(a) above may be made for any process by welding a single test coupon of either plate or pipe, of any material, thickness or diameter, in any position, and by testing of that coupon as required by QW-301 and QW-302. A successful test renews the welder or welding operator's previous qualifications for that process for those materials, thicknesses, diameters, positions, and other variables for which he was previously qualified.

Providing the conditions of QW-304 and QW-305 are satisfied, renewal of qualification under QW-322.1(a) may be done on production work.

(b) Welders and welding operators whose qualifications have been revoked under QW-322.1(b) above shall requalify. Qualification shall utilize a test coupon appropriate to the planned production work. The coupon shall be welded and tested as required by QW-301 and QW-302. Successful test restores the qualification.

QW-350 WELDING VARIABLES FOR WELDERS

A00 **QW-351 General**

A welder shall be requalified whenever a change is made in one or more of the essential variables listed for each welding process.

Where a combination of welding processes is required to make a weldment, each welder shall be qualified for the particular welding process or processes he will be required to use in production welding. A welder may be qualified by making tests with each individual welding process, or with a combination of welding processes in a single test coupon.

The limits of weld metal thickness for which he will be qualified are dependent upon the approximate thickness of the weld metal he deposits with each welding process, exclusive of any weld reinforcement, this thickness shall be considered the test coupon thickness as given in QW-452.

In any given production weldment, welders may not deposit a thickness greater than that permitted by QW-452 for each welding process in which they are qualified.

QW-352 OXYFUEL GAS WELDING (OFW)
Essential Variables

Paragraph		Brief of Variables
QW-402 Joints	.7	+ Backing
QW-403 Base Metals	.2	Maximum qualified
	.18	ϕ P-Number
QW-404 Filler Metals	.14	$\pm$ Filler
	.15	ϕ F-Number
	.31	ϕ *t* Weld deposit
QW-405 Positions	.1	+ Position
QW-408 Gas	.7	ϕ Type fuel gas

QW-353 SHIELDED METAL-ARC WELDING (SMAW)
Essential Variables

Paragraph		Brief of Variables
QW-402 Joints	.4	– Backing
QW-403 Base Metals	.16	ϕ Pipe diameter
	.18	ϕ P-Number
QW-404 Filler Metals	.15	ϕ F-Number
	.30	ϕ *t* Weld deposit
QW-405 Positions	.1	+ Position
	.3	ϕ $\uparrow\downarrow$ Vertical welding

QW-354 SEMIAUTOMATIC SUBMERGED-ARC WELDING (SAW)
Essential Variables

Paragraph		Brief of Variables
QW-403 Base Metals	.16	ϕ Pipe diameter
	.18	ϕ P-Number
QW-404 Filler Metals	.15	ϕ F-Number
	.30	ϕ *t* Weld deposit
QW-405 Positions	.1	+ Position

ARTICLE IV
WELDING DATA

QW-400 VARIABLES

QW-401 General

Each welding variable described in this Article is applicable as an essential, supplemental essential, or nonessential variable for procedure qualification when referenced in QW-250 for each specific welding process. Essential variables for performance qualification are referenced in QW-350 for each specific welding process. A change from one welding process to another welding process is an essential variable and requires requalification.

QW-401.1 Essential Variable (Procedure). A change in a welding condition which will affect the mechanical properties (other than notch toughness) of the weldment (for example, change in P-Number, welding process, filler metal, electrode, preheat or postweld heat treatment, etc.).

QW-401.2 Essential Variable (Performance). A change in a welding condition which will affect the ability of a welder to deposit sound weld metal (such as a change in welding process, deletion of backing, electrode, F-Number, technique, etc.).

QW-401.3 Supplemental Essential Variable (Procedure). A change in a welding condition which will affect the notch-toughness properties of a weldment (for example, change in welding process, uphill or down vertical welding, heat input, preheat or PWHT, etc.).

When a procedure has been previously qualified to satisfy all requirements other than notch toughness, it is then necessary only to prepare an additional test coupon using the same procedure with the same essential variables, but additionally with all of the required supplementary essential variables, with the coupon long enough to provide the necessary notch-toughness specimens.

When a procedure has been previously qualified to satisfy all requirements including notch toughness, but one or more supplementary essential variable is changed, then it is only necessary to prepare an additional test coupon using the same welding procedure and the new supplementary essential variable(s), with the coupon long enough to provide the necessary notch-toughness specimens. If a previously qualified weld procedure has satisfactory notch-toughness values in the weld metal, then it is necessary only to test notch-toughness specimens from the heat affected zone when such are required.

QW-401.4 Nonessential Variable (Procedure). A change in a welding condition which will *not* affect the mechanical properties of a weldment (such as joint design, method of back gouging or cleaning, etc.)

QW-401.5 The welding data includes the welding variables grouped as joints, base metals, filler metals, position, preheat, postweld heat treatment, gas, electrical characteristics, and technique. For convenience, variables for each welding process are summarized in QW-416 for performance qualification.

QW-402 Joints

QW-402.1 A change in the type of groove (Vee-groove, U-groove, single-bevel, double-bevel, etc.).

QW-402.2 The addition or deletion of a backing.

QW-402.3 A change in the nominal composition of the backing.

QW-402.4 The deletion of the backing in single-welded groove welds. Double-welded groove welds are considered welding with backing.

QW-402.5 The addition of a backing or a change in its nominal composition.

QW-402.6 An increase in the fit-up gap, beyond that initially qualified.

QW-402.7 The addition of backing.

QW-402.8 A change in nominal size or shape of the stud at the section to be welded.

QW-402.9 In stud welding, a change in shielding as a result of ferrule or flux type.

QW-402.10 A change in the specified root spacing.

QW-402.11 The addition or deletion of nonmetallic retainers or nonfusing metal retainers.

QW-402.12 The welding procedure qualification test shall duplicate the joint configuration to be used in production within the limits listed, except that pipe or tube to pipe or tube may be used for qualification of a pipe or tube to other shapes, and solid round to solid round may be used for qualification of a solid round to other shapes:

(a) any change exceeding ±10 deg. in the angle measured for the plane of either face to be joined, to the axis of rotation;

(b) a change in cross-sectional area of the weld joint greater than 10%;

(c) a change in the outside diameter of the cylindrical weld interface of the assembly greater than ±10%;

(d) a change from solid to tubular cross section at the joint or vice versa regardless of (b) above.

QW-402.13 A change in the joint from spot to projection to seam or vice versa.

QW-402.14 A decrease in the center-to-center distance when the welds overlap. An increase or decrease of more than 10% in the spacing of the welds when they are within two diameters of each other.

QW-402.15 A change in the size or shape of the projection in projection welding.

A00 **QW-402.16** A decrease in the distance between the approximate weld interface and the final surface of the production corrosion-resistant or hard-facing weld metal overlay below the minimum thickness qualified as shown in QW-462.5(a) through QW-462.5(e). There is no limit on the maximum thickness for corrosion-resistant or hard-facing weld metal overlay that may be used in production.

QW-402.17 An increase in the thickness of the production spray fuse hard-facing deposit above the thickness deposited on the procedure qualification test coupon.

A00 **QW-402.18** When the joint is a lap joint, the following additional variables shall apply:

(a) a change of more than 10% in the distance to the edge of the material;

(b) a change of more than 10% in the joint overlap;

(c) a change in the number of layers of material;

(d) a change in the method of surface conditioning at the metal-to-metal interfaces.

QW-403 Base Metals

QW-403.1 A change from a base metal listed under one P-Number in QW/QB-422 to a metal listed under another P-Number or to any other base metal. When joints are made between two base metals that have different P-Numbers, a procedure qualification shall be made for the applicable combination of P-Numbers, even though qualification tests have been made for each of the two base metals welded to itself.

QW-403.2 The maximum thickness qualified is the thickness of the test coupon.

QW-403.3 Where the measurement of penetration can be made by visual or mechanical means, requalification is required where the base metal thickness differs by 20% from that of the test coupon thickness when the test coupon thickness is 1 in. (25 mm) and under, and 10% when the test coupon thickness is over 1 in. (25 mm) Where the measurement of penetration cannot be made, requalification is required where the base metal thickness differs by 10% from that of the test coupon when the test coupon thickness is 1 in. (25 mm) and under, and 5% when the test coupon thickness is over 1 in. (25 mm).

QW-403.4 Welding procedure qualifications shall be made using a base metal of the same type or grade or another base metal listed in the same group (see QW/QB-422) as the base metal to be used in production welding. When joints are to be made between base metals from two different groups, a procedure qualification must be made for the applicable combination of base metals, even though procedure qualification tests have been made for each of the two base metals welded to itself.

QW-403.5 Welding procedure qualifications shall be made using a base metal of the same type or grade or another base metal listed in the same P-Number and Group Number (see QW/QB-422) as the base metal to be used in production welding. A procedure qualification shall be made for each P-Number and Group Number combination of base metals, even though procedure qualification tests have been made for each of the two base metals welded to itself. If, however, the procedure specification for welding the combination

of base metals specifies the same essential variables, including electrode or filler metal, as both specifications for welding each base metal to itself, such that base metals is the only change, then the procedure specification for welding the combination of base metals is also qualified. In addition, when base metals of two different P-Number Group Number combinations are qualified

QW-420 Material Groupings

A99 **QW-420.1 P-Numbers.** To reduce the number of welding and brazing procedure qualifications required, base metals have been assigned P-Numbers, and for ferrous base metals which have specified impact test requirements, Group Numbers within P-Numbers. These assignments are based essentially on comparable base metal characteristics, such as composition, weldability, brazeability, and mechanical properties, where this can logically be done. These assignments do not imply that base metals may be indiscriminately substituted for a base metal which was used in the qualification test without consideration of compatibility from the standpoint of metallurgical properties, postweld heat treatment, design, mechanical properties, and service requirements. Where notch toughness is a consideration, it is presupposed that the base metals meet the specific requirements.

Base Metal	Welding	Brazing
Steel and steel alloys	P-No. 1 through P-No. 11 incl. P-No. 5A, 5B, and 5C	P-No. 101 through P-No. 103
Aluminum and aluminum-base alloys	P-No. 21 through P-No. 25	P-No. 104 and P-No. 105
Copper and copper-base alloys	P-No. 31 through P-No. 35	P-No.107 and P-No. 108
Nickel and nickel-base alloys	P-No. 41 through P-No. 47	P-No. 110 through P-No. 112
Titanium and titanium-base alloys	P-No. 51 through P-No. 53	P-No. 115
Zirconium and zirconium-base alloys	P-No. 61 through P-No. 62	P-No. 117

When a base metal with a UNS number designation is assigned a P-Number or P-Number plus Group Number, then a base metal listed in a different ASME material specification with the same UNS number shall be considered that P-Number or P-Number plus Group Number. For example, SB-163, UNS N08800 is P-Number 45; therefore, all ASME specifications listing a base metal with the UNS N08800 designation shall be considered P-Number 45 (i.e., SB-407, SB-408, SB-514, etc.) whether or not these specifications are listed in QW/QB-422. Since a minimum tensile value is required for procedure qualification, only base metals listed in QW/QB-422 may be used for test coupons as defined in QW-424.

In those instances where materials in the 1971 Edition of this Section have been given different P-Numbers or assigned to Subgroups within a P-Number in the 1974 Edition of this Section, those procedure and performance qualifications will continue to be valid based on the new P-Number designation.

In the column heading "Minimum Specified Tensile, ksi" of QW/QB-422, the values given are those of the base metal specification, except as otherwise identified in QW-153 or QB-153. These are also the acceptance values for the room temperature tensile tests of the welding or brazing procedure qualification, except as otherwise allowed in QW-153 or QB-153.

QW-420.2 S-Numbers (Non-Mandatory). S-Numbers are a listing of materials which are acceptable for use by the ASME B31 Code for Pressure Piping, or by selected Boiler and and Pressure Vessel Code Cases, but which are not included within ASME Boiler and Pressure Code Material Specifications (Section II). These materials are grouped in S-Number or S-Number plus Group Number groupings similar to the P-Number groupings. There is no mandatory requirement that S-Numbers be used. A99

Brazing or Welding Procedure Qualification with a base metal in one P-Number (or P-Number plus Group Number) or one S-Number (or S-Number plus Group Number), qualifies for all other base metals in the same S-Number grouping. Also, qualification with a base metal in one S-Number, or S-Number plus Group Number, qualifies for all other base metals in the same S-Number grouping. Qualifications for S-Number materials do not qualify corresponding P-Number materials. Base metals not assigned an S-Number or a P-Number shall require individual procedure qualification.

Material produced under an ASTM specification shall be considered to have the same S-Number or S-Number plus Group Number as that of the P-Number or P-Number plus Group Number assigned to the same grade or type material in the corresponding ASME specification (i.e., SA-240 Type 304 is assigned P-Number 8, Group Number 1; therefore, A 240 Type 304 is considered S-Number 8, Group Number 1). Additionally, when a base metal with a UNS number designation is assigned an S-Number or S-Number plus Group Number, then a base metal listed in a different material specification with the same UNS number shall be considered that S-Number or S-Number plus Group Number. Since a minimum tensile value is required for procedure qualification, only base metals listed in QW/QB-422 may be used for test coupons.

For Performance Qualification of brazers, welders, brazing operators, and welding operators, the requirements for P-Numbers of base metals shall also be applied to the same S-Numbers of base metals. Qualification with P-Numbers in accordance with QB-310.3 and QW-403.18 qualifies for corresponding S-Numbers and vice versa.

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-36	...	K02600	58	1	1	...	...	101	...	C–Mn–Si	Plate, bar, & shapes
SA-53	Type F	...	48	1	1	...	...	101	...	C	Furnace welded pipe
SA-53	Type S, Gr. A	K02504	48	1	1	...	...	101	...	C	Smls. pipe
SA-53	Type E, Gr. A	K02504	48	1	1	...	...	101	...	C	Resistance welded pipe
SA-53	Type E, Gr. B	K03005	60	1	1	...	...	101	...	C–Mn	Resistance welded pipe
SA-53	Type S, Gr. B	K03005	60	1	1	...	...	101	...	C–Mn	Smls. pipe
SA-105	...	K03504	70	1	2	...	...	101	...	C–Si	Flanges & fittings
SA-106	A	K02501	48	1	1	...	...	101	...	C–Si	Smls. pipe
SA-106	B	K03006	60	1	1	...	...	101	...	C–Si	Smls. pipe
SA-106	C	K03501	70	1	2	...	...	101	...	C–Si	Smls. pipe
A 108	1015 CW	G10150	60	...	...	1	1	...	101	C	Bar
A 108	1018 CW	G10180	60	...	...	1	1	...	101	C	Bar
A 108	1020 CW	G10200	60	...	...	1	1	...	101	C	Bar
SA-134	SA283 Gr. A	...	45	1	1	...	...	101	...	C	Welded pipe
SA-134	SA283 Gr. B	...	50	1	1	...	...	101	...	C	Welded pipe
SA-134	SA283 Gr. C	K02401	55	1	1	...	...	101	...	C	Welded pipe
SA-134	SA283 Gr. D	K02702	60	1	1	...	...	101	...	C	Welded pipe
SA-134	SA285 Gr. A	K01700	45	1	1	...	...	101	...	C	Welded pipe
SA-134	SA285 Gr. B	K02200	50	1	1	...	...	101	...	C	Welded pipe
SA-134	SA285 Gr. C	K02801	55	1	1	...	...	101	...	C	Welded pipe
SA-135	A	...	48	1	1	...	...	101	...	C	E.R.W. pipe
SA-135	B	...	60	1	1	...	...	101	...	C	E.R.W. pipe
A 139	A	...	48	...	...	1	1	...	101	C	Welded pipe
A 139	B	K03003	60	...	...	1	1	...	101	C	Welded pipe
A 139	C	K03004	60	...	...	1	1	...	101	C	Welded pipe
A 139	D	K03010	60	...	...	1	1	...	101	C	Welded pipe
A 139	E	K03012	66	...	...	1	1	...	101	C	Welded pipe
A 148	90–60	...	90	...	...	4	3	...	103	...	Castings
A 167	Type 301	S30100	75	...	...	8	1	...	102	17Cr–7Ni	Plate, sheet, & strip
A 167	Type 302	S30200	75	...	...	8	1	...	102	18Cr–8Ni	Plate, sheet, & strip
A 167	Type 302B	S30215	75	...	...	8	1	...	102	18Cr–8Ni–2Si	Plate, sheet, & strip

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 167	Type 304	S30400	75	...	...	8	1	...	102	18Cr–8Ni	Plate, sheet, & strip
A 167	Type 304L	S30403	70	...	...	8	1	...	102	18Cr–8Ni	Plate, sheet, & strip
A 167	Type 305	S30500	70	...	...	8	1	...	102	18Cr–11Ni	Plate, sheet, & strip
A 167	Type 308	S30800	75	...	...	8	2	...	102	20Cr–10Ni	Plate, sheet, & strip
A 167	Type 309	S30900	75	...	...	8	2	...	102	23Cr–12Ni	Plate, sheet, & strip
A 167	Type 309S	S30908	75	...	...	8	2	...	102	23Cr–12Ni	Plate, sheet, & strip
A 167	Type 310	S31000	75	...	...	8	2	...	102	25Cr–20Ni	Plate, sheet, & strip
A 167	Type 310S	S31008	75	...	...	8	2	...	102	25Cr–20Ni	Plate, sheet, & strip
A 167	Type 316L	S31603	70	...	...	8	1	...	102	16Cr–12Ni–2Mo	Plate, sheet, & strip
A 167	Type 317	S31700	75	...	...	8	1	...	102	18Cr–13Ni–3Mo	Plate, sheet, & strip
A 167	Type 317L	S31703	75	...	...	8	1	...	102	18Cr–13Ni–3Mo	Plate, sheet, & strip
A 167	Type 321	S32100	75	...	...	8	1	...	102	18Cr–10Ni–Ti	Plate, sheet, & strip
A 167	Type 347	S34700	75	...	...	8	1	...	102	18Cr–10Ni–Cb	Plate, sheet, & strip
A 167	Type 348	S34800	75	...	...	8	1	...	102	18Cr–10Ni–Cb	Plate, sheet, & strip
SA-178	A	K01200	47	1	1	...	...	101	...	C	E.R.W. tube
SA-178	C	K03503	60	1	1	...	...	101	...	C	E.R.W. tube
SA-178	D	...	70	1	2	...	...	101	...	C–Mn–Si	E.R.W. tube
SA-179	...	K01200	47	1	1	...	...	101	...	C	Smls. tube
SA-181	Cl. 60	K03502	60	1	1	...	...	101	...	C–Si	Pipe flange & fittings
SA-181	Cl. 70	K03502	70	1	2	...	...	101	...	C–Si	Pipe flange & fittings
SA-182	F12, Cl. 1	K11562	60	4	1	...	...	102	...	1Cr–0.5Mo	Forgings
SA-182	F12, Cl. 2	K11564	70	4	1	...	...	102	...	1Cr–0.5Mo	Forgings
SA-182	F11, Cl. 2	K11572	70	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-182	F11, Cl. 3	K11572	75	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-182	F11, Cl. 1	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-182	F2	K12122	70	3	2	...	...	101	...	0.5Cr–0.5Mo	Forgings
SA-182	F1	K12822	70	3	2	...	...	101	...	C–0.5Mo	Forgings
SA-182	F22, Cl. 1	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Forgings
SA-182	F22, Cl. 3	K21590	75	5A	1	...	...	102	...	2.25Cr–1Mo	Forgings
SA-182	FR	K22035	63	9A	1	...	...	101	...	2Ni–1Cu	Forgings
SA-182	F21	K31545	75	5A	1	...	...	102	...	3Cr–1Mo	Forgings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-182	F3V	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Forgings
SA-182	F22V	K31835	85	5C	1	...	...	102	...	2.25Cr–1Mo–V	Forgings
SA-182	F5	K41545	70	5B	1	...	...	102	...	5Cr–0.5Mo	Forgings
SA-182	F5a	K42544	90	5B	1	...	...	102	...	5Cr–0.5Mo	Forgings
SA-182	F9	K90941	85	5B	1	...	...	102	...	9Cr–1Mo	Forgings
SA-182	F91	K91560	85	5B	2	...	...	102	...	9Cr–1Mo–V	Forgings
SA-182	F6a, Cl. 1	K91151	70	6	1	...	...	102	...	13Cr	Forgings
SA-182	F6a, Cl. 2	K91151	85	6	3	...	...	102	...	13Cr	Forgings
SA-182	FXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Forgings
SA-182	FXM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Forgings
SA-182	F304	S30400	70	8	1	...	...	102	...	18Cr–8Ni	Forgings > 5 in.
SA-182	F304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-182	F304L	S30403	65	8	1	...	...	102	...	18Cr–8Ni	Forgings > 5 in.
SA-182	F304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-182	F304H	S30409	70	8	1	...	...	102	...	18Cr–8Ni	Forgings > 5 in.
SA-182	F304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-182	F304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Forgings
SA-182	F304LN	S30453	70	8	1	...	...	102	...	18Cr–8Ni–N	Forgings > 5 in.
SA-182	F304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Forgings
SA-182	F46	S30600	78	8	1	...	...	102	...	17Cr–14Ni–4Si	Forgings
SA-182	F45	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Forgings
SA-182	F310	S31000	70	8	2	...	...	102	...	25Cr–20Ni	Forgings > 5 in.
SA-182	F310	S31000	75	8	2	...	...	102	...	25Cr–20Ni	Forgings
SA-182	F50	S31200	100	10H	1	...	...	102	...	25Cr–6Ni–Mo–N	Forgings
SA-182	F44	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Forgings
SA-182	F316	S31600	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings > 5 in.
SA-182	F316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-182	F316L	S31603	65	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings > 5 in.
SA-182	F316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-182	F316H	S31609	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings > 5 in.
SA-182	F316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-182	F316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forgings
SA-182	F316LN	S31653	70	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forgings > 5 in.
SA-182	F316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forgings
SA-182	F317	S31700	70	8	1	...	...	102	...	18Cr–13Ni–3Mo	Forgings > 5 in.

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-182	F317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Forgings
SA-182	F317L	S31703	65	8	1	...	...	102	...	18Cr–13Ni–3Mo	Forgings > 5 in.
SA-182	F317L	S31703	70	8	1	...	...	102	...	18Cr–13Ni–3Mo	Forgings
SA-182	F51	S31803	90	10H	1	...	...	102	...	22Cr–5Ni–3Mo–N	Forgings
SA-182	F321	S32100	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings > 5 in.
SA-182	F321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings
SA-182	F321H	S32109	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings > 5 in.
SA-182	F321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings
SA-182	F55	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Forgings
SA-182	F10	S33100	80	8	2	...	...	102	...	20Ni–8Cr	Forgings
SA-182	F347	S34700	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings > 5 in.
SA-182	F347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-182	F347H	S34709	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings > 5 in.
SA-182	F347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-182	F348	S34800	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings > 5 in.
SA-182	F348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-182	F348H	S34809	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings > 5 in.
SA-182	F348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-182	F6b	S41026	110	6	3	...	...	102	...	13Cr–0.5Mo	Forgings
SA-182	F6NM	S41500	115	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Forgings
SA-182	F429	S42900	60	6	2	...	...	102	...	15Cr	Forgings
SA-182	F430	S43000	60	7	2	...	...	102	...	17Cr	Forgings
SA-182	FXM–27Cb	S44627	60	10I	1	...	...	102	...	27Cr–1Mo	Forgings
A 182	F6a, Cl. 3	S41000	110	...	...	6	3	...	102	13Cr	Forgings
A 182	F6a, Cl. 4	S41000	130	...	...	6	3	...	102	13Cr–5Mo	Forgings
SA-192	...	K01201	47	1	1	...	...	101	...	C–Si	Smls. tube
SA-199	T11	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Smls. tube
SA-199	T22	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Smls. tube
SA-199	T4	K31509	60	5A	1	...	...	102	...	2.25Cr–0.5Mo–0.75Si	Smls. tube
SA-199	T21	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Smls. tube
SA-199	T5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Smls. tube
SA-199	T9	K81590	60	5B	1	...	...	102	...	9Cr–1Mo	Smls. tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-199	T91	...	85	5B	2	...	...	102	...	9Cr–1Mo–V	Smls. tube
SA-202	A	K11742	75	4	1	...	...	101	...	0.5Cr–1.25Mn–Si	Plate
SA-202	B	K12542	85	4	1	...	...	101	...	0.5Cr–1.25Mn–Si	Plate
SA-203	A	K21703	65	9A	1	...	...	101	...	2.5Ni	Plate
SA-203	B	K22103	70	9A	1	...	...	101	...	2.5Ni	Plate
SA-203	D	K31718	65	9B	1	...	...	101	...	3.5Ni	Plate
SA-203	E	K32018	70	9B	1	...	...	101	...	3.5Ni	Plate
SA-203	F	K32018	75	9B	1	...	...	101	...	3.5Ni	Plate > 2 in.
SA-203	F	K32018	80	9B	1	...	...	101	...	3.5Ni	Plate, 2 in. & under
SA-204	A	K11820	65	3	1	...	...	101	...	C–0.5Mo	Plate
SA-204	B	K12020	70	3	2	...	...	101	...	C–0.5Mo	Plate
SA-204	C	K12320	75	3	2	...	...	101	...	C–0.5Mo	Plate
SA-209	T1b	K11422	53	3	1	...	...	101	...	C–0.5Mo	Smls. tube
SA-209	T1	K11522	55	3	1	...	...	101	...	C–0.5Mo	Smls. tube
SA-209	T1a	K12023	60	3	1	...	...	101	...	C–0.5Mo	Smls. tube
SA-210	A–1	K02707	60	1	1	...	...	101	...	C–Si	Smls. tube
SA-210	C	K03501	70	1	2	...	...	101	...	C–Mn–Si	Smls. tube
A 211	A570-30	K02502	49	...	...	1	1	...	101	C	Welded pipe
A 211	A570-33	K02502	52	...	...	1	1	...	101	C	Welded pipe
A 211	A570-40	K02502	55	...	...	1	1	...	101	C	Welded pipe
SA-213	T2	K11547	60	3	1	...	...	101	...	0.5Cr–0.5Mo	Smls. tube
SA-213	T12	K11562	60	4	1	...	...	102	...	1Cr–0.5Mo	Smls. tube
SA-213	T11	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Smls. tube
SA-213	T17	K12047	60	10B	1	...	...	102	...	1Cr–V	Smls. tube
SA-213	T22	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Smls. tube
SA-213	T21	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Smls. tube
SA-213	T5c	K41245	60	5B	1	...	...	102	...	5Cr–0.5Mo–Ti	Smls. tube
SA-213	T5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Smls. tube
SA-213	T5b	K51545	60	5B	1	...	...	102	...	5Cr–0.5Mo–Si	Smls. tube
SA-213	T9	K81590	60	5B	1	...	...	102	...	9Cr–1Mo	Smls. tube
SA-213	T91	...	85	5B	2	...	...	102	...	9Cr–1Mo–V	Smls. tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-213	TP201	S20100	95	8	3	...	...	102	...	17Cr–4Ni–6Mn	Smls. tube
SA-213	TP202	S20200	90	8	3	...	...	102	...	18Cr–5Ni–9Mn	Smls. tube
SA-213	XM-19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Smls. tube
SA-213	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Smls. tube
SA-213	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Smls. tube
SA-213	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Smls. tube
SA-213	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Smls. tube
SA-213	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Smls. tube
SA-213	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Smls. tube
SA-213	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Smls. tube
SA-213	TP309H	S30909	75	8	2	...	...	102	...	23Cr–12Ni	Smls. tube
SA-213	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Smls. tube
SA-213	TP309HCb	S30941	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Smls. tube
SA-213	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Smls. tube
SA-213	TP310H	S31009	75	8	2	...	...	102	...	25Cr–20Ni	Smls. tube
SA-213	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Smls. tube
SA-213	TP310HCb	S31041	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Smls. tube
SA-213	TP310MoLN	S31050	78	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Smls. tube, $t > 1/4$ in.
SA-213	TP310MoLN	S31050	84	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Smls. tube, $t \leq 1/4$ in.
SA-213	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. tube
SA-213	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. tube
SA-213	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. tube
SA-213	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. tube
SA-213	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. tube
SA-213	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Smls. tube
SA-213	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Smls. tube
SA-213	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. tube
SA-213	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. tube
SA-213	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. tube
SA-213	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. tube
SA-213	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. tube
SA-213	TP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. tube
SA-213	XM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Smls. tube
SA-214	...	K01807	47	1	1	...	...	101	...	C	E.R.W. tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-216	WCA	J02502	60	1	1	...	...	101	...	C–Si	Castings
SA-216	WCC	J02503	70	1	2	...	...	101	...	C–Mn–Si	Castings
SA-216	WCB	J03002	70	1	2	...	...	101	...	C–Si	Castings
SA-217	WC6	J12072	70	4	1	...	...	102	...	1.25Cr–0.5Mo	Castings
SA-217	WC4	J12082	70	4	1	...	...	101	...	1Ni–0.5Cr–0.5Mo	Castings
SA-217	WC1	J12522	65	3	1	...	...	101	...	C–0.5Mo	Castings
SA-217	WC9	J21890	70	5A	1	...	...	102	...	2.25Cr–1Mo	Castings
SA-217	WC5	J22000	70	4	1	...	...	101	...	0.75Ni–1Mo–0.75Cr	Castings
SA-217	C5	J42025	90	5B	1	...	...	102	...	5Cr–0.5Mo	Castings
SA-217	C12	J82090	90	5B	1	...	...	102	...	9Cr–1Mo	Castings
SA-217	CA15	J91150	90	6	3	...	...	102	...	13Cr	Castings
SA-225	D	...	75	10A	1	...	...	101	...	Mn–0.5Ni–V	Plate > 3 in.
SA-225	D	...	80	10A	1	...	...	101	...	Mn–0.5Ni–V	Plate, 3 in. & under
SA-225	C	K12524	105	10A	1	...	...	101	...	Mn–0.5Ni–V	Plate
SA-226	...	K01201	47	1	1	...	...	101	...	C–Si	E.R.W. tube
SA-234	WPB	K03006	60	1	1	...	...	101	...	C–Si	Piping fitting
SA-234	WPC	K03501	70	1	2	...	...	101	...	C–Si	Piping fitting
SA-234	WP11, Cl. 1	...	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Piping fitting
SA-234	WP12, Cl. 1	K12062	60	4	1	...	...	101	...	1Cr–0.5Mo	Piping fitting
SA-234	WP1	K12821	55	3	1	...	...	101	...	C–0.5Mo	Piping fitting
SA-234	WP22, Cl. 1	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Piping fitting
SA-234	WPR	K22035	63	9A	1	...	...	101	...	2Ni–1Cu	Piping fitting
SA-234	WP5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Piping fitting
SA-234	WP9	K90941	60	5B	1	...	...	102	...	9Cr–1Mo	Piping fitting
SA-234	WP91	...	85	5B	2	...	...	102	...	9Cr–1Mo–V	Piping fitting
SA-240	Type 201	S20100	95	8	3	...	...	102	...	17Cr–4Ni–6Mn	Plate, sheet, & strip
SA-240	Type 202	S20200	90	8	3	...	...	102	...	18Cr–5Ni–9Mn	Plate, sheet, & strip
SA-240	...	S20400	95	8	3	...	...	102	...	16Cr–9Mn–2Ni–N	Plate, sheet, & strip
SA-240	Type XM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Plate
SA-240	Type XM–19	S20910	105	8	3	...	...	102	...	22Cr–13Ni–5Mn	Sheet & strip
SA-240	Type XM–17	S21600	90	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Plate
SA-240	Type XM–17	S21600	100	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Sheet & strip
SA-240	Type XM–18	S21603	90	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Plate
SA-240	Type XM–18	S21603	100	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Sheet & strip
SA-240	S21800	S21800	95	8	3	...	...	102	...	18Cr–8Ni–4Si–N	Plate, sheet, & strip

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-240	Type XM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Plate, sheet, & strip
SA-240	Type 302	S30200	75	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-240	Type 304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-240	Type 304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-240	Type 304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-240	Type 304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Plate, sheet, & strip
SA-240	Type XM–21	S30452	85	8	1	...	...	102	...	18Cr–8Ni–N	Plate
SA-240	Type XM–21	S30452	90	8	1	...	...	102	...	18Cr–8Ni–N	Sheet & strip
SA-240	Type 304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Plate, sheet, & strip
SA-240	Type 305	S30500	70	8	1	...	...	102	...	18Cr–11Ni	Plate, sheet, & strip
SA-240	S30600	S30600	78	8	1	...	...	102	...	17Cr–14Ni–4Si	Plate, sheet, & strip
SA-240	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Plate, sheet, & strip
SA-240	Type 309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Plate, sheet, & strip
SA-240	Type 309H	S30909	75	8	2	...	...	102	...	23Cr–12Ni	Plate, sheet, & strip
SA-240	Type 309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Plate, sheet, & strip
SA-240	Type 309HCb	S30941	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Plate, sheet, & strip
SA-240	Type 310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Plate, sheet, & strip
SA-240	Type 310H	S31009	75	8	2	...	...	102	...	20Cr–20Ni	Plate, sheet, & strip
SA-240	Type 310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Plate, sheet, & strip
SA-240	Type 310HCb	S31041	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Plate, sheet, & strip
SA-240	Type 310MoLN	S31050	80	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Plate, sheet, & strip
SA-240	S31200	S31200	100	10H	1	...	...	102	...	25Cr–6Ni–Mo–N	Plate, sheet, & strip
SA-240	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Plate, sheet, & strip
SA-240	S31260	S31260	100	10H	1	...	...	102	...	25Cr–6.5Ni–3Mo–N	Plate, sheet, & strip
SA-240	Type 316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Plate, sheet, & strip
SA-240	Type 316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Plate, sheet, & strip
SA-240	Type 316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Plate, sheet, & strip
SA-240	Type 316Ti	S31635	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–Ti	Plate, sheet, & strip
SA-240	Type 316Cb	S31640	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–Cb	Plate, sheet, & strip
SA-240	Type 316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Plate, sheet, & strip
SA-240	Type 316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Plate, sheet, & strip
SA-240	Type 317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Plate, sheet, & strip
SA-240	Type 317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Plate, sheet, & strip
SA-240	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Plate, sheet, & strip

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-240	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Plate, sheet, & strip
SA-240	S31753	S31753	80	8	1	...	...	102	...	18Cr–13Ni–3Mo–N	Plate, sheet, & strip
SA-240	S31803	S31803	90	10H	1	...	...	...	...	22Cr–5Ni–3Mo–N	Plate, sheet, & strip
SA-240	Type 321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Plate, sheet, & strip
SA-240	Type 321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Plate, sheet, & strip
SA-240	S32550	S32550	110	10H	1	...	...	102	...	25Cr–5Ni–3Mo–2Cu	Plate, sheet, & strip
SA-240	S32760	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Plate, sheet, & strip
SA-240	Type 329	S32900	90	10H	1	...	...	102	...	26Cr–4Ni–Mo	Plate, sheet, & strip
SA-240	S32950	S32950	90	10H	1	...	...	102	...	26Cr–4Ni–Mo–N	Plate, sheet, & strip
SA-240	Type 347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Plate, sheet, & strip
SA-240	Type 347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Plate, sheet, & strip
SA-240	Type 348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Plate, sheet, & strip
SA-240	Type 348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Plate, sheet, & strip
SA-240	Type XM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Plate, sheet, & strip
SA-240	Type 405	S40500	60	7	1	...	...	102	...	12Cr–1Al	Plate, sheet, & strip
SA-240	Type 409	S40900	55	7	1	...	...	102	...	11Cr–Ti	Plate, sheet, & strip
SA-240	Type 410	S41000	65	6	1	...	...	102	...	13Cr	Plate, sheet, & strip
SA-240	Type 410S	S41008	60	7	1	...	...	102	...	13Cr	Plate, sheet, & strip
SA-240	S41500	S41500	115	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Plate, sheet, & strip
SA-240	Type 429	S42900	65	6	2	...	...	102	...	15Cr	Plate, sheet, & strip
SA-240	Type 430	S43000	65	7	2	...	...	102	...	17Cr	Plate, sheet, & strip
SA-240	Type 439	S43035	65	7	2	...	...	102	...	17Cr–Ti	Plate, sheet, & strip
SA-240	S44400	S44400	60	7	2	...	...	102	...	18Cr–2Mo	Plate, sheet, & strip
SA-240	Type XM–33	S44626	68	10I	1	...	...	102	...	27Cr–1Mo–Ti	Plate, sheet, & strip
SA-240	Type XM–27	S44627	65	10I	1	...	...	102	...	27Cr–1Mo	Plate, sheet, & strip
SA-240	S44635	S44635	90	10I	1	...	...	102	...	25Cr–4Ni–4Mo–Ti	Plate, sheet, & strip
SA-240	S44660	S44660	85	10K	1	...	...	102	...	26Cr–3Ni–3Mo	Plate, sheet, & strip
SA-240	S44700	S44700	80	10J	1	...	...	102	...	29Cr–4Mo	Plate, sheet, & strip
SA-240	S44800	S44800	80	10K	1	...	...	102	...	29Cr–4Mo–2Ni	Plate, sheet, & strip
SA-249	TP201	S20100	95	8	3	...	...	102	...	17Cr–4Ni–6Mn	Welded tube
SA-249	TP202	S20200	90	8	3	...	...	102	...	18Cr–5Ni–9Mn	Welded tube
SA-249	TPXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Welded tube
SA-249	TPXM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Welded tube
SA-249	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Welded tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-249	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Welded tube
SA-249	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Welded tube
SA-249	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Welded tube
SA-249	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Welded tube
SA-249	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Welded tube
SA-249	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Welded tube
SA-249	TP309H	S30909	75	8	2	...	...	102	...	23Cr–12Ni	Welded tube
SA-249	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Welded tube
SA-249	TP309HCb	S30941	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Welded tube
SA-249	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Welded tube
SA-249	TP310H	S31009	75	8	2	...	...	102	...	25Cr–20Ni	Welded tube
SA-249	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Welded tube
SA-249	TP310HCb	S31041	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Welded tube
SA-249	TP310MoLN	S31050	78	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Welded tube, $t > 1/4$ in.
SA-249	TP310MoLN	S31050	84	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Welded tube, $t \leq 1/4$ in.
SA-249	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Welded tube
SA-249	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded tube
SA-249	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded tube
SA-249	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded tube
SA-249	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded tube
SA-249	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded tube
SA-249	TP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Welded tube
SA-249	TP317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Welded tube
SA-249	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Welded tube
SA-249	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Welded tube
SA-249	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded tube
SA-249	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded tube
SA-249	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded tube
SA-249	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded tube
SA-249	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded tube
SA-249	TP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded tube
SA-249	TPXM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Welded tube
SA-250	T1b	K11422	53	3	1	...	...	101	...	C–0.5Mo	E.R.W. tube
SA-250	T1	K11522	55	3	1	...	...	101	...	C–0.5Mo	E.R.W. tube
SA-250	T2	K11547	60	3	1	...	...	101	...	0.5Cr–0.5Mo	E.R.W. tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-250	T11	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	E.R.W. tube
SA-250	T1a	K12023	60	3	1	...	...	101	...	C–0.5Mo	E.R.W. tube
SA-250	T22	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	E.R.W. tube
A 254	Cl.1	K01001	42	...	...	...	...	...	101	C	Cu brazed tube
A 254	Cl.2	K01001	42	...	...	...	...	...	101	C	Cu brazed tube
SA-266	4	K03017	70	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-266	1	K03506	60	1	1	...	...	101	...	C–Si	Forgings
SA-266	2	K03506	70	1	2	...	...	101	...	C–Si	Forgings
SA-266	3	K05001	75	1	2	...	...	101	...	C–Si	Forgings
SA-268	TP405	S40500	60	7	1	...	...	102	...	12Cr–1Al	Smls. & welded tube
SA-268	S40800	S40800	55	7	1	...	...	102	...	12Cr–Ti	Smls. & welded tube
SA-268	TP409	S40900	55	7	1	...	...	102	...	11Cr–Ti	Smls. & welded tube
SA-268	TP410	S41000	60	6	1	...	...	102	...	13Cr	Smls. & welded tube
SA 268	S41500	S41500	115	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Smls. & welded tube
SA-268	TP429	S42900	60	6	2	...	...	102	...	15Cr	Smls. & welded tube
SA-268	TP430	S43000	60	7	2	...	...	102	...	17Cr	Smls. & welded tube
SA-268	TP439	S43035	60	7	2	...	...	102	...	18Cr–Ti	Smls. & welded tube
SA-268	TP430Ti	S43036	60	7	1	...	...	102	...	18Cr–Ti–Cb	Smls. & welded tube
SA-268	18Cr–2Mo	S44400	60	7	2	...	...	102	...	18Cr–2Mo	Smls. & welded tube
SA-268	TP446–2	S44600	65	10I	1	...	...	102	...	27Cr	Smls. & welded tube
SA-268	TP446–1	S44600	70	10I	1	...	...	102	...	27Cr	Smls. & welded tube
SA-268	TPXM–33	S44626	68	10I	1	...	...	102	...	27Cr–1Mo–Ti	Smls. & welded tube
SA-268	TPXM–27	S44627	65	10I	1	...	...	102	...	27Cr–1Mo	Smls. & welded tube
SA-268	25–4–4	S44635	90	10I	1	...	...	102	...	25Cr–4Ni–4Mo–Ti	Smls. & welded tube
SA-268	26–3–3	S44660	85	10K	1	...	...	102	...	26Cr–3Ni–3Mo	Smls. & welded tube
SA-268	29–4	S44700	80	10J	1	...	...	102	...	29Cr–4Mo	Smls. & welded tube
SA-268	S44735	S44735	75	10J	1	...	...	102	...	29Cr–4Mo–Ti	Smls. & welded tube
SA-268	29–4–2	S44800	80	10K	1	...	...	102	...	29Cr–4Mo–2Ni	Smls. & welded tube
A 269	TP316	S31600	75	...	...	8	1	...	102	16Cr–12Ni–2Mo	Smls. & welded tube
A 269	TP316L	S31603	70	...	...	8	1	...	102	16Cr–12Ni–2Mo	Smls. & welded tube
A 269	TP304	S30400	75	...	...	8	1	...	102	18Cr–8Ni	Smls. & welded tube
A 269	TP304L	S30403	70	...	...	8	1	...	102	18Cr–8Ni	Smls. & welded tube

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 271	TP304	S30400	75	...	...	8	1	...	102	18Cr–8Ni	Smls. tube
A 271	TP304L	S30403	70	...	...	8	1	...	102	18Cr–8Ni	Smls. tube
A 276	TP304	S30400	75	...	...	8	1	...	102	18Cr–8Ni	Bar
A 276	TP304L	S30403	70	...	...	8	1	...	102	18Cr–8Ni	Bar
A 276	TP316	S31600	75	...	...	8	1	...	102	16Cr–12Ni–2Mo	Bar
A 276	TP316L	S31603	70	...	...	8	1	...	102	16Cr–12Ni–2Mo	Bar
A 276	TP410	S41000	65	...	...	6	1	...	102	13Cr	Bar
SA-283	A	...	45	1	1	...	...	101	...	C	Plate
SA-283	B	...	50	1	1	...	...	101	...	C	Plate
SA-283	C	...	55	1	1	...	...	101	...	C	Plate
SA-283	D	...	60	1	1	...	...	101	...	C	Plate
SA-285	A	K01700	45	1	1	...	...	101	...	C	Plate
SA-285	B	K02200	50	1	1	...	...	101	...	C	Plate
SA-285	C	K02801	55	1	1	...	...	101	...	C	Plate
SA-299	...	K02803	75	1	2	...	...	101	...	C–Mn–Si	Plate
SA-302	A	K12021	75	3	2	...	...	101	...	Mn–0.5Mo	Plate
SA-302	B	K12022	80	3	3	...	...	101	...	Mn–0.5Mo	Plate
SA-302	C	K12039	80	3	3	...	...	101	...	Mn–0.5Mo–0.5Ni	Plate
SA-302	D	K12054	80	3	3	...	...	101	...	Mn–0.5Mo–0.75Ni	Plate
SA-312	TPXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Smls. & welded pipe
SA-312	TPXM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Smls. & welded pipe
SA-312	TPXM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Smls. & welded pipe
SA-312	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Smls. & welded pipe
SA-312	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Smls. & welded pipe
SA-312	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Smls. & welded pipe
SA-312	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Smls. & welded pipe
SA-312	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Smls. & welded pipe
SA-312	S30600	S30600	78	8	1	...	...	102	...	17Cr–14Ni–4Si	Smls. & welded pipe
SA-312	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Smls. & welded pipe
SA-312	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Smls. & welded pipe
SA-312	TP309H	S30909	75	8	2	...	...	102	...	23Cr–12Ni	Smls. & welded pipe
SA-312	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Smls. & welded pipe
SA-312	TP309HCb	S30941	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Smls. & welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-312	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Smls. & welded pipe
SA-312	TP310H	S31009	75	8	2	...	...	102	...	25Cr–20Ni	Smls. & welded pipe
SA-312	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Smls. & welded pipe
SA-312	TP310HCb	S31041	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Smls. & welded pipe
SA-312	TP310MoLN	S31050	78	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Welded pipe, $t > 1/4$ in.
SA-312	TP310MoLN	S31050	84	8	2	...	...	102	...	25Cr–22Ni–2Mo–N	Welded pipe, $t \leq 1/4$ in.
SA-312	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Smls. & welded pipe
SA-312	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. & welded pipe
SA-312	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. & welded pipe
SA-312	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. & welded pipe
SA-312	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. & welded pipe
SA-312	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. & welded pipe
SA-312	TP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Smls. & welded pipe
SA-312	TP317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Smls. & welded pipe
SA-312	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Smls. & welded pipe
SA-312	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Smls. & welded pipe
SA-312	TP321	S32100	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Seamless pipe $> 3/8$ in.
SA-312	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Seamless pipe $\leq 3/8$ in.
SA-312	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded pipe
SA-312	TP321H	S32109	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Seamless pipe $> 3/8$ in.
SA-312	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Seamless pipe $\leq 3/8$ in.
SA-312	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded pipe
SA-312	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. & welded pipe
SA-312	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. & welded pipe
SA-312	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. & welded pipe
SA-312	TP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. & welded pipe
SA-312	TPXM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Smls. & welded pipe
A 331	8620 CW	G86200	90	...	...	3	3	...	102	0.5Ni–0.5Cr–Mo	Bar
SA-333	6	K03006	60	1	1	...	...	101	...	C–Mn–Si	Smls. & welded pipe
SA-333	1	K03008	55	1	1	...	...	101	...	C–Mn	Smls. & welded pipe
SA-333	10	...	80	1	3	...	...	101	...	C–Mn–Si	Smls. & welded pipe
SA-333	4	K11267	60	4	2	...	...	102	...	0.75Cr–0.75Ni–Cu–Al	Smls. & welded pipe
SA-333	7	K21903	65	9A	1	...	...	101	...	2.5Ni	Smls. & welded pipe
SA-333	9	K22035	63	9A	1	...	...	101	...	2Ni–1Cu	Smls. & welded pipe
SA-333	3	K31918	65	9B	1	...	...	101	...	3.5Ni	Smls. & welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-333	8	K81340	100	11A	1	...	...	101	...	9Ni	Smls. & welded pipe
SA-334	6	K03006	60	1	1	...	...	101	...	C–Mn–Si	Welded tube
SA-334	1	K03008	55	1	1	...	...	101	...	C–Mn	Welded tube
SA-334	7	K21903	65	9A	1	...	...	101	...	2.5Ni	Welded tube
SA-334	9	K22035	63	9A	1	...	...	101	...	2Ni–1Cu	Welded tube
SA-334	3	K31918	65	9B	1	...	...	101	...	3.5Ni	Welded tube
SA-334	8	K81340	100	11A	1	...	...	101	...	9Ni	Welded tube
SA-335	P1	K11522	55	3	1	...	...	101	...	C–0.5Mo	Smls. pipe
SA-335	P2	K11547	55	3	1	...	...	101	...	0.5Cr–0.5Mo	Smls. pipe
SA-335	P12	K11562	60	4	1	...	...	102	...	1Cr–0.5Mo	Smls. pipe
SA-335	P15	K11578	60	3	1	...	...	101	...	1.5Si–0.5Mo	Smls. pipe
SA-335	P11	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Smls. pipe
SA-335	P22	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Smls. pipe
SA-335	P21	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Smls. pipe
SA-335	P5c	K41245	60	5B	1	...	...	102	...	5Cr–0.5Mo–Ti	Smls. pipe
SA-335	P5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Smls. pipe
SA-335	P5b	K51545	60	5B	1	...	...	102	...	5Cr–0.5Mo–Si	Smls. pipe
SA-335	P9	K81590	60	5B	1	...	...	102	...	9Cr–1Mo	Smls. pipe
SA-335	P91	K91560	85	5B	2	...	...	102	...	9Cr–1Mo–V	Smls. pipe
SA-336	F6	...	85	6	3	...	...	102	...	13Cr	Forgings
SA-336	F12	K11564	70	4	1	...	...	102	...	1Cr–0.5Mo	Forgings
SA-336	F11, Cl. 1	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-336	F11, Cl. 2	K11572	70	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-336	F11, Cl. 3	K11572	75	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-336	F1	K12520	70	3	2	...	...	101	...	C–0.5Mo	Forgings
SA-336	F22, Cl. 1	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Forgings
SA-336	F22, Cl. 3	K21590	75	5A	1	...	...	102	...	2.25Cr–1Mo	Forgings
SA-336	F21, Cl. 1	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Forgings
SA-336	F21, Cl. 3	K31545	75	5A	1	...	...	102	...	3Cr–1Mo	Forgings
SA-336	F3V	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Forgings
SA-336	F22V	K31835	85	5C	1	...	...	102	...	2.25Cr–1Mo–V	Forgings
SA-336	F5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Forgings
SA-336	F5A	K42544	80	5B	1	...	...	102	...	5Cr–0.5Mo	Forgings
SA-336	F9	K81590	85	5B	1	...	...	102	...	9Cr–1Mo	Forgings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-336	F91	...	85	5B	2	...	...	102	...	9Cr–1Mo–V	Forgings
SA-336	F46	S30600	78	8	1	...	...	102	...	17Cr–14Ni–4Si	Forgings
SA-336	FXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Forgings
SA-336	FXM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Forgings
SA-336	F304	S30400	70	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-336	F304L	S30403	65	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-336	F304H	S30409	70	8	1	...	...	102	...	18Cr–8Ni	Forgings
SA-336	F304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Forgings
SA-336	F304LN	S30453	70	8	1	...	...	102	...	18Cr–8Ni–N	Forgings
SA-336	F310	S31000	75	8	2	...	...	102	...	25Cr–20Ni	Forgings
SA-336	F316	S31600	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-336	F316L	S31603	65	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-336	F316H	S31609	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forgings
SA-336	F316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forgings
SA-336	F316LN	S31653	70	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forgings
SA-336	F321	S32100	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings
SA-336	F321H	S32109	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forgings
SA-336	F347	S34700	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-336	F347H	S34709	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-336	F348	S34800	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-336	F348H	S34809	65	8	1	...	...	102	...	18Cr–10Ni–Cb	Forgings
SA-350	LF1	K03009	60	1	1	...	...	101	...	C–Mn–Si	Forgings
SA-350	LF2	K03011	70	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-350	LF5, Cl. 1	K13050	60	9A	1	...	...	101	...	1.5Ni	Forgings
SA-350	LF5, Cl. 2	K13050	70	9A	1	...	...	101	...	1.5Ni	Forgings
SA-350	LF9	K22036	63	9A	1	...	...	101	...	2Ni–1Cu	Forgings
SA-350	LF3	K32025	70	9B	1	...	...	101	...	3.5Ni	Forgings
SA-351	CF3	J92500	70	8	1	...	...	102	...	18Cr–8Ni	Castings
SA-351	CF3A	J92500	77	8	1	...	...	102	...	18Cr–8Ni	Castings
SA-351	CF8	J92600	70	8	1	...	...	102	...	18Cr–8Ni	Castings
SA-351	CF8A	J92600	77	8	1	...	...	102	...	18Cr–8Ni	Castings
SA-351	CF8C	J92710	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Castings
SA-351	CF3M	J92800	70	8	1	...	...	102	...	18Cr–12Ni–2Mo	Castings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-351	CF8M	J92900	70	8	1	...	...	102	...	18Cr–12Ni–2Mo	Castings
SA-351	CF10	J92590	70	8	1	...	...	102	...	19Cr–9Ni–0.5Mo	Castings
SA-351	CF10M	...	70	8	1	...	...	102	...	19Cr–9Ni–2Mo	Castings
SA-351	CG8M	J93000	75	8	1	...	...	102	...	19Cr–10Ni–3Mo	Castings
SA-351	CK3MCuN	J93254	80	8	4	...	...	102	...	20Cr–18Ni–6Mo	Castings
SA-351	CE8MN	J93345	95	10H	1	...	...	102	...	24Cr–10Ni–Mo–N	Castings
SA-351	CD4MCu	J93370	100	10H	1	...	...	102	...	25Cr–5Ni–2Mo–3Cu	Castings
SA-351	CD3MWCuN	J93380	100	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Castings
SA-351	CH8	J93400	65	8	2	...	...	102	...	25Cr–12Ni	Castings
SA-351	CH20	J93402	70	8	2	...	...	102	...	25Cr–12Ni	Castings
SA-351	CG6MMN	J93790	85	8	3	...	...	102	...	22Cr–12Ni–5Mn	Castings
SA-351	CK20	J94202	65	8	2	...	...	102	...	25Cr–20Ni	Castings
SA-351	CN7M	N08007	62	45	...	...	...	111	...	28Ni–19Cr–Cu–Mo	Castings
SA-351	CT15C	N08151	63	45	...	...	...	111	...	32Ni–45Fe–20Cr–Cb	Castings
SA-351	CN3MN	J94651	80	45	...	...	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Castings
A 351	CA15	...	90	...	...	6	3	...	102	13Cr	Castings
A 351	CE20N	...	80	...	...	8	2	...	102	25Cr–8Ni–N	Castings
A 351	CF10MC	J92971	70	...	...	8	1	...	102	16Cr–14Ni–2Mo	Castings
A 351	CH10	J93401	70	...	...	8	2	...	102	25Cr–12Ni	Castings
A 351	HK30	...	65	...	...	8	2	...	102	25Cr–20Ni–0.5Mo	Castings
A 351	HK40	J94204	62	...	...	8	2	...	102	25Cr–20Ni–0.5Mo	Castings
A 351	HT30	N08030	65	...	...	45	...	...	111	32Ni–45Fe–15Cr	Castings
SA-352	LCA	J02504	60	1	1	...	...	101	...	C–Si	Castings
SA-352	LCC	J02505	70	1	2	...	...	101	...	C–Mn–Si	Castings
SA-352	LCB	J03003	65	1	1	...	...	101	...	C–Si	Castings
SA-352	LC1	J12522	65	3	1	...	...	101	...	C–0.5Mo	Castings
SA-352	LC2	J22500	70	9A	1	...	...	101	...	2.5Ni	Castings
SA-352	LC3	J31550	70	9B	1	...	...	101	...	3.5Ni	Castings
SA-352	LC4	J41500	70	9C	1	...	...	101	...	4.5Ni	Castings
SA-352	LC2–1	J42215	105	11A	5	...	...	102	...	3Ni–1.5Cr–0.5Mo	Castings
SA-352	CA6NM	J91540	110	6	4	...	...	102	...	13Cr–4Ni	Castings
SA-353	...	K81340	100	11A	1	...	...	101	...	9Ni	Plate
SA-358	XM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Fusion welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-358	XM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Fusion welded pipe
SA-358	304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Fusion welded pipe
SA-358	304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Fusion welded pipe
SA-358	304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Fusion welded pipe
SA-358	304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Fusion welded pipe
SA-358	304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Fusion welded pipe
SA-358	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Fusion welded pipe
SA-358	309	S30900	75	8	2	...	...	102	...	23Cr–12Ni	Fusion welded pipe
SA-358	309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Fusion welded pipe
SA-358	309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Fusion welded pipe
SA-358	310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Fusion welded pipe
SA-358	310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Fusion welded pipe
SA-358	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Fusion welded pipe
SA-358	316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Fusion welded pipe
SA-358	316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Fusion welded pipe
SA-358	316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Fusion welded pipe
SA-358	316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Fusion welded pipe
SA-358	316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Fusion welded pipe
SA-358	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Fusion welded pipe
SA-358	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Fusion welded pipe
SA-358	321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Fusion welded pipe
SA-358	347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Fusion welded pipe
SA-358	348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Fusion welded pipe
SA-369	FPA	K02501	48	1	1	...	...	101	...	C–Si	Forged pipe
SA-369	FPB	K03006	60	1	1	...	...	101	...	C–Mn–Si	Forged pipe
SA-369	FP1	K11522	55	3	1	...	...	101	...	C–0.5Mo	Forged pipe
SA-369	FP2	K11547	55	3	1	...	...	101	...	0.5Cr–0.5Mo	Forged pipe
SA-369	FP12	K11562	60	4	1	...	...	102	...	1Cr–0.5Mo	Forged pipe
SA-369	FP11	K11597	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forged pipe
SA-369	FP22	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Forged pipe
SA-369	FP21	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Forged pipe
SA-369	FP5	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Forged pipe
SA-369	FP9	K90941	60	5B	1	...	...	102	...	9Cr–1Mo	Forged pipe
SA-369	FP91	...	85	5B	2	...	...	102	...	9Cr–1Mo–V	Forged pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-372	A	K03002	60	1	1	...	...	101	...	C–Si	Forgings
SA-372	B	K04001	75	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-376	16–8–2H	S16800	75	8	1	...	...	102	...	16Cr–8Ni–2Mo	Smls. pipe
SA-376	TP304	S30400	70	8	1	...	...	102	...	18Cr–8Ni	Smls. pipe ≥ 0.812 in.
SA-376	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Smls. pipe < 0.812 in.
SA-376	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Smls. pipe
SA-376	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Smls. pipe
SA-376	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Smls. pipe
SA-376	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. pipe
SA-376	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Smls. pipe
SA-376	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. pipe
SA-376	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Smls. pipe
SA-376	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Smls. pipe
SA-376	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Smls. pipe
SA-376	TP321	S32100	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe > $^3/_8$ in.
SA-376	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe ≤ $^3/_8$ in.
SA-376	TP321H	S32109	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe > $^3/_8$ in.
SA-376	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Smls. pipe ≤ $^3/_8$ in.
SA-376	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. pipe
SA-376	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. pipe
SA-376	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Smls. pipe
A 381	Y35	K03013	60	...	...	1	1	...	101	C	Welded pipe
A 381	Y42	...	60	...	...	1	1	...	101	C	Welded pipe
A 381	Y48	...	62	...	...	1	1	...	101	C	Welded pipe > $^3/_8$ in.
A 381	Y46	...	63	...	...	1	1	...	101	C	Welded pipe
A 381	Y50	...	64	...	...	1	1	...	101	C	Welded pipe > $^3/_8$ in.
A 381	Y52	...	66	...	...	1	2	...	101	C	Welded pipe > $^3/_8$ in.
A 381	Y56	...	71	...	...	1	2	...	101	C	Welded pipe > $^3/_8$ in.
A 381	Y52	...	72	...	...	1	2	...	101	C	Welded pipe, to $^3/_8$ in.
A 381	Y56	...	75	...	...	1	2	...	101	C	Welded pipe, to $^3/_8$ in.
A 381	Y60	...	75	...	...	1	2	...	101	C	Welded pipe > $^3/_8$ in.
A 381	Y60	...	78	...	...	1	2	...	101	C	Welded pipe > $^3/_8$ in.
SA-387	12, Cl. 1	K11757	55	4	1	...	...	102	...	1Cr–0.5Mo	Plate
SA-387	12, Cl. 2	K11757	65	4	1	...	...	102	...	1Cr–0.5Mo	Plate

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-387	11, Cl. 1	K11789	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Plate
SA-387	11, Cl. 2	K11789	75	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Plate
SA-387	Gr. 2, Cl. 1	K12143	55	3	1	...	...	101	...	0.5Cr–0.5Mo	Plate
SA-387	Gr. 2, Cl. 2	K12143	70	3	2	...	...	101	...	0.5Cr–0.5Mo	Plate
SA-387	22, Cl. 1	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-387	22, Cl. 2	K21590	75	5A	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-387	21, Cl. 1	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Plate
SA-387	21, Cl. 2	K31545	75	5A	1	...	...	102	...	3Cr–1Mo	Plate
SA-387	5, Cl. 1	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Plate
SA-387	5, Cl. 2	K41545	75	5B	1	...	...	102	...	5Cr–0.5Mo	Plate
SA-387	Gr. 91, Cl. 2	...	85	5B	2	...	...	102	...	9Cr–1Mo–V	Plate
SA-403	WPXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Wrought piping fittings
SA-403	WP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Wrought piping fittings
SA-403	WP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Wrought piping fittings
SA-403	WP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Wrought piping fittings
SA-403	WP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Wrought piping fittings
SA-403	WP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Wrought piping fittings
SA-403	WP309	S30900	75	8	2	...	...	102	...	23Cr–12Ni	Wrought piping fittings
SA-403	WP310	S31000	75	8	2	...	...	102	...	25Cr–20Ni	Wrought piping fittings
SA-403	WP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Wrought piping fittings
SA-403	WP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Wrought piping fittings
SA-403	WP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Wrought piping fittings
SA-403	WP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Wrought piping fittings
SA-403	WP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Wrought piping fittings
SA-403	WP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Wrought piping fittings
SA-403	WP317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Wrought piping fittings
SA-403	WP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Wrought piping fittings
SA-403	WP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Wrought piping fittings
SA-403	WP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Wrought piping fittings
SA-403	WP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Wrought piping fittings
SA-403	WP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Wrought piping fittings
SA-403	WP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Wrought piping fittings
SA-409	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Welded pipe
SA-409	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-409	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Welded pipe
SA-409	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Welded pipe
SA-409	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Welded pipe
SA-409	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Welded pipe
SA-409	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Welded pipe
SA-409	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Welded pipe
SA-409	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded pipe
SA-409	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded pipe
SA-409	TP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Welded pipe
SA-409	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Welded pipe
SA-409	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Welded pipe
SA-409	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded pipe
SA-409	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-409	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-414	A	K01501	45	1	1	...	...	101	...	C	Sheet
SA-414	B	K02201	50	1	1	...	...	101	...	C	Sheet
SA-414	C	K02503	55	1	1	...	...	101	...	C	Sheet
SA-414	D	K02505	60	1	1	...	...	101	...	C–Mn	Sheet
SA-414	E	K02704	65	1	1	...	...	101	...	C–Mn	Sheet
SA-414	F	K03102	70	1	2	...	...	101	...	C–Mn	Sheet
SA-414	G	K03103	75	1	2	...	...	101	...	C–Mn	Sheet
SA-420	WPL6	...	60	1	1	...	...	101	...	C–Mn–Si	Piping fitting
SA-420	WPL9	K22035	63	9A	1	...	...	101	...	2Ni–1Cu	Piping fitting
SA-420	WPL3	...	65	9B	1	...	...	101	...	3.5Ni	Piping fitting
SA-420	WPL8	K81340	100	11A	1	...	...	101	...	9Ni	Piping fitting
SA-423	1	K11535	60	4	2	...	...	102	...	0.75Cr–0.5Ni–Cu	Smls. & welded tube
SA-423	2	K11540	60	4	2	...	...	102	...	0.75Ni–0.5Cu–Mo	Smls. & welded tube
SA-426	CP15	J11522	60	3	1	...	...	101	...	C–0.5Mo–Si	Centrifugal cast pipe
SA-426	CP2	J11547	60	3	1	...	...	101	...	0.5Cr–0.5Mo	Centrifugal cast pipe
SA-426	CP12	J11562	60	4	1	...	...	102	...	1Cr–0.5Mo	Centrifugal cast pipe
SA-426	CP11	J12072	70	4	1	...	...	102	...	1.25Cr–0.5Mo	Centrifugal cast pipe
SA-426	CP1	J12521	65	3	1	...	...	101	...	C–0.5Mo	Centrifugal cast pipe
SA-426	CP22	J21890	70	5A	1	...	...	102	...	2.25Cr–1Mo	Centrifugal cast pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-426	CP21	J31545	60	5A	1	...	...	102	...	3Cr–1Mo	Centrifugal cast pipe
SA-426	CP5	J42045	90	5B	1	...	...	102	...	5Cr–0.5Mo	Centrifugal cast pipe
SA-426	CP5b	J51545	60	5B	1	...	...	102	...	5Cr–1.5Si–0.5Mo	Centrifugal cast pipe
SA-426	CP9	J82090	90	5B	1	...	...	102	...	9Cr–1Mo	Centrifugal cast pipe
SA-426	CPCA15	J91150	90	6	3	...	...	102	...	13Cr	Centrifugal cast pipe
SA-430	FP16–8–2H	S16800	70	8	1	...	...	102	...	16Cr–8Ni–2Mo	Forged pipe
SA-430	FP304	S30400	70	8	1	...	...	102	...	18Cr–8Ni	Forged pipe
SA-430	FP304H	S30409	70	8	1	...	...	102	...	18Cr–8Ni	Forged pipe
SA-430	FP304N	S30451	75	8	1	...	...	102	...	18Cr–8Ni–N	Forged pipe
SA-430	FP316	S31600	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forged pipe
SA-430	FP316H	S31609	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Forged pipe
SA-430	FP316N	S31651	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Forged pipe
SA-430	FP321	S32100	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forged pipe
SA-430	FP321H	S32109	70	8	1	...	...	102	...	18Cr–10Ni–Ti	Forged pipe
SA-430	FP347	S34700	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forged pipe
SA-430	FP347H	S34709	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Forged pipe
A 441	1	K12211	70	...	...	1	2	...	101	Mn–Cu–V	Shapes
A 441	2	K12211	70	...	...	1	2	...	101	Mn–Cu–V	Shapes
A 446	A	...	45	...	...	1	1	...	101	C	Sheet
SA-451	CPF8	J92600	70	8	1	...	...	102	...	18Cr–8Ni	Centrifugal cast pipe
SA-451	CPF8A	J92600	77	8	1	...	...	102	...	18Cr–8Ni	Centrifugal cast pipe
SA-451	CPF8C	J92710	70	8	1	...	...	102	...	18Cr–10Ni–Cb	Centrifugal cast pipe
SA-451	CPF8M	J92900	70	8	1	...	...	102	...	18Cr–12Ni–2Mo	Centrifugal cast pipe
SA-451	CPF3	J92500	70	8	1	...	...	102	...	18Cr–8Ni	Centrifugal cast pipe
SA-451	CPF3M	J92800	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Centrifugal cast pipe
SA-451	CPF3A	J92500	77	8	1	...	...	102	...	18Cr–8Ni	Centrifugal cast pipe
SA-451	CPH8	J93400	65	8	2	...	...	102	...	25Cr–12Ni	Centrifugal cast pipe
SA-451	CPH20	J93402	70	8	2	...	...	102	...	25Cr–12Ni	Centrifugal cast pipe
SA-451	CPK20	J94202	65	8	2	...	...	102	...	25Cr–20Ni	Centrifugal cast pipe
A 451	CPF10MC	J92971	70	...	...	8	1	...	102	16Cr–14Ni–2Mo	Centrifugal cast pipe
A 451	CPE20N	...	80	...	...	8	2	...	102	25Cr–8Ni–N	Centrifugal cast pipe
SA-452	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Centrifugal cast pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-452	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Centrifugal cast pipe
SA-452	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Centrifugal cast pipe
SA-455	...	K03300	70	1	2	...	...	101	...	C–Mn–Si	Plate > 0.580 in.–0.750 in.
SA-455	...	K03300	73	1	2	...	...	101	...	C–Mn–Si	Plate > 0.375 in.–0.580 in.
SA-455	...	K03300	75	1	2	...	...	101	...	C–Mn–Si	Plate, up to 0.375 in.
SA-479	XM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Bars & shapes
SA-479	XM–17	S21600	90	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Bars & shapes
SA-479	XM–18	S21603	90	8	3	...	...	102	...	19Cr–8Mn–6Ni–Mo–N	Bars & shapes
SA-479	S21800	S21800	95	8	3	...	...	102	...	18Cr–8Ni–4Si–N	Bars & shapes
SA-479	XM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Bars & shapes
SA-479	XM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Bars & shapes
SA-479	302	S30200	75	8	1	...	...	102	...	18Cr–8Ni	Bars & shapes
SA-479	304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Bars & shapes
SA-479	304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Bars & shapes
SA-479	304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Bars & shapes
SA-479	304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Bars & shapes
SA-479	304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Bars & shapes
SA-479	S30600	S30600	78	8	1	...	...	102	...	17Cr-14Ni-4Si	Bars & shapes
SA-479	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Bars & shapes
SA-479	309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Bars & shapes
SA-479	309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Bars & shapes
SA-479	310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Bars & shapes
SA-479	310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Bars & shapes
SA-479	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Bars & shapes
SA-479	316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Bars & shapes
SA-479	316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Bars & shapes
SA-479	316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Bars & shapes
SA-479	316Ti	S31635	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–Ti	Bars & shapes
SA-479	316Cb	S31640	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–Cb	Bars & shapes
SA-479	316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Bars & shapes
SA-479	316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Bars & shapes
SA-479	S31725	S31725	75	8	4	...	...	102	...	19Cr–15Ni–4Mo	Bars & shapes
SA-479	S31726	S31726	80	8	4	...	...	102	...	19Cr–15.5Ni–4Mo	Bars & shapes
SA-479	321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Bars & shapes

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-479	321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Bars & shapes
SA-479	S32550	S32550	110	10H	1	...	...	102	...	25Cr–5Ni–3Mo–2Cu	Bars & shapes
SA-479	347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Bars & shapes
SA-479	347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Bars & shapes
SA-479	348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Bars & shapes
SA-479	348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Bars & shapes
SA-479	403	S40300	70	6	1	...	...	102	...	12Cr	Bars & shapes
SA-479	405	S40500	60	7	1	...	...	102	...	12Cr–1Al	Bars & shapes
SA-479	410	S41000	70	6	1	...	...	102	...	13Cr	Bars & shapes
SA-479	414	S41400	115	6	4	...	...	102	...	12.5Cr–2Ni–Si	Bars & shapes
SA-479	S41500	S41500	115	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Bars & shapes
SA-479	430	S43000	70	7	2	...	...	102	...	17Cr	Bars & shapes
SA-479	439	S43035	70	7	2	...	...	102	...	17Cr–Ti	Bars & shapes
SA-479	S44400	S44400	60	7	2	...	...	102	...	18Cr–2Mo	Bars & shapes
SA-479	XM–27	S44627	65	10I	1	...	...	102	...	27Cr–1Mo	Bars & shapes
SA-479	S44700	S44700	70	10J	1	...	...	102	...	29Cr–4Mo	Bars & shapes
SA-479	S44800	S44800	70	10K	1	...	...	102	...	29Cr–4Mo–2Ni	Bars & shapes
SA-487	Gr. 16, Cl. A	...	70	1	2	...	...	101	...	Low C–Mn–Ni	Castings
SA-487	Gr. 1, Cl. A	J03004	85	10A	1	...	...	101	...	Mn–V	Castings
SA-487	Gr. 1, Cl. B	J03004	90	10A	1	...	...	101	...	Mn–V	Castings
SA-487	Gr. 2, Cl. A	J13005	85	3	3	...	...	101	...	Mn–0.25Mo–V	Castings
SA-487	Gr. 2, Cl. B	J13005	90	3	3	...	...	101	...	Mn–0.25Mo–V	Castings
SA-487	Gr. 4, Cl. A	J13047	90	3	3	...	...	101	...	0.5Ni–0.5Cr–0.25Mo–V	Castings
SA-487	Gr. 4, Cl. B	J13047	105	11A	3	...	...	101	...	0.5Ni–0.5Cr–0.25Mo–V	Castings
SA-487	Gr. 4, Cl. E	J13047	115	11A	3	...	...	101	...	0.5Ni–0.5Cr–0.25Mo–V	Castings
SA-487	Gr. 8, Cl. A	J22091	85	5C	1	...	...	102	...	2.25Cr–1Mo	Castings
SA-487	Gr. 8, Cl. C	J22091	100	5C	4	...	...	102	...	2.25Cr–1Mo	Castings
SA-487	Gr. 8, Cl. B	J22091	105	5C	4	...	...	102	...	2.25Cr–1Mo	Castings
SA-487	CA15M Cl. A	J91151	90	6	3	...	...	102	...	13Cr	Castings
SA-487	CA15 Cl. C	J91171	90	6	3	...	...	102	...	13Cr	Castings
SA-487	CA15 Cl. B	J91171	90	6	3	...	...	102	...	13Cr	Castings
SA-487	CA15 Cl. D	J91171	100	6	3	...	...	102	...	13Cr	Castings
SA-487	CA6NM Cl. B	J91540	100	6	4	...	...	102	...	13Cr–4Ni	Castings
SA-487	CA6NM Cl. A	J91540	110	6	4	...	...	102	...	13Cr–4Ni	Castings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-494	CX2MW	N26022	80	44	...	...	...	112	...	59Ni–22Cr–14Mo–4Fe–3W	Castings
A 494	CW-6M	N30107	72	...	...	44	...	...	112	56Ni–19Mo–18Cr–2Fe	Castings
A 500	C	K02705	62	...	...	1	1	...	101	C	Tube
A 500	B	K03000	58	...	...	1	1	...	101	C	Tube
A 501	...	K03000	58	...	...	1	1	...	101	C	Tube
SA-508	3, Cl. 1	K12042	80	3	3	...	...	101	...	0.75Ni–0.5Mo–Cr–V	Forgings
SA-508	3, Cl. 2	K12042	90	3	3	...	...	102	...	0.75Ni–0.5Mo–Cr–V	Forgings
SA-508	2, Cl. 1	K12766	80	3	3	...	...	101	...	0.75Ni–0.5Mo–0.3Cr–V	Forgings
SA-508	2, Cl. 2	K12766	90	3	3	...	...	101	...	0.75Ni–0.5Mo–0.3Cr–V	Forgings
SA-508	1	K13502	70	1	2	...	...	101	...	C–Si	Forgings
SA-508	1A	...	70	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-508	22, Cl. 3	K21590	85	5C	1	...	...	...	...	2.25Cr–1Mo	Forgings
SA-508	4N, Cl. 3	K22375	90	3	3	...	...	102	...	3.5Ni–1.75Cr–0.5Mo–V	Forgings
SA-508	4N, Cl. 1	K22375	105	11A	5	...	...	102	...	3.5Ni–1.75Cr–0.5Mo–V	Forgings
SA-508	4N, Cl. 2	K22375	115	11A	5	...	...	102	...	3.5Ni–1.75Cr–0.5Mo–V	Forgings
SA-508	3V	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Forgings
SA-508	5, Cl. 1	K42365	105	11A	5	...	...	102	...	3.5Ni–1.75Cr–0.5Mo–V	Forgings
SA-508	5, Cl. 2	K42365	115	11A	5	...	...	102	...	3.5Ni–1.75Cr–0.5Mo–V	Forgings
A 513	1015 CW	G10150	65	...	...	1	1	...	101	C	Tube
A 513	1020 CW	G10200	70	...	...	1	2	...	101	C	Tube
A 513	1025 CW	G10250	75	...	...	1	2	...	101	C	Tube
A 513	1026 CW	G10260	80	...	...	1	3	...	101	C	Tube
A 514	F	K11576	110	...	...	11B	3	...	101	0.75Ni–0.5Cr–0.5Mo–V	Plate, $2^1/_2$ in. max.
A 514	J	K11625	110	...	...	11B	6	...	101	C–0.5Mo	Plate, $1^1/_4$ in. max.
A 514	B	K11630	110	...	...	11B	4	...	101	0.5Cr–0.2Mo–V	Plate, $1^1/_4$ in. max.
A 514	D	K11662	110	...	...	11B	5	...	101	1Cr–0.2Mo–Si	Plate, $1^1/_4$ in. max.
A 514	A	K11856	110	...	...	11B	1	...	101	0.5Cr–0.25Mo–Si	Plate, $1^1/_4$ in. max.
A 514	E	K21604	100	...	...	11B	2	...	102	1.75Cr–0.5Mo–Cu	Plate > $2^1/_2$ in.–6 in., incl.
A 514	E	K21604	110	...	...	11B	2	...	102	1.75Cr–0.5Mo–Cu	Plate, $2^1/_2$ in. max.
A 514	P	K21650	100	...	...	11B	8	...	102	1.25Ni–1Cr–0.5Mo	Plate > $2^1/_2$ in.–6 in., incl.
A 514	P	K21650	110	...	...	11B	8	...	102	1.25Ni–1Cr–0.5Mo	Plate, $2^1/_2$ in. max.
A 514	Q	...	100	...	...	11B	9	...	102	1.3Ni–1.3Cr–0.5Mo–V	Plate > $2^1/_2$ in.–6 in., incl.

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 514	Q	...	110	...	...	11B	9	...	102	1.3Ni–1.3Cr–0.5Mo–V	Plate, $2^1/_2$ in. max.
SA-515	60	K02401	60	1	1	...	...	101	...	C–Si	Plate
SA-515	65	K02800	65	1	1	...	...	101	...	C–Si	Plate
SA-515	70	K03101	70	1	2	...	...	101	...	C–Si	Plate
SA-516	55	K01800	55	1	1	...	...	101	...	C–Si	Plate
SA-516	60	K02100	60	1	1	...	...	101	...	C–Mn–Si	Plate
SA-516	65	K02403	65	1	1	...	...	101	...	C–Mn–Si	Plate
SA-516	70	K02700	70	1	2	...	...	101	...	C–Mn–Si	Plate
SA-517	F	K11576	115	11B	3	...	...	101	...	0.75Ni–0.5Cr–0.5Mo–V	Plate ≤ $2^1/_2$ in.
SA-517	J	K11625	115	11B	6	...	...	101	...	C–0.5Mo	Plate ≤ $1^1/_4$ in.
SA-517	B	K11630	115	11B	4	...	...	101	...	0.5Cr–0.2Mo–V	Plate ≤ $1^1/_4$ in.
SA-517	A	K11856	115	11B	1	...	...	101	...	0.5Cr–0.25Mo–Si	Plate ≤ $1^1/_4$ in.
SA-517	E	K21604	105	11B	2	...	...	102	...	1.75Cr–0.5Mo–Cu	Plate > $2^1/_2$ in.–6 in.
SA-517	E	K21604	115	11B	2	...	...	102	...	1.75Cr–0.5Mo–Cu	Plate ≤ $2^1/_2$ in.
SA-517	P	K21650	105	11B	8	...	...	102	...	1.25Ni–1Cr–0.5Mo	Plate > $2^1/_2$ in.–4 in.
SA-517	P	K21650	115	11B	8	...	...	102	...	1.25Ni–1Cr–0.5Mo	Plate ≤ $2^1/_2$ in.
A 519	1018 HR	G10180	50	...	...	1	1	...	101	C	Tube
A 519	1018 CW	G10180	70	...	...	1	2	...	101	C	Tube
A 519	1020 HR	G10200	50	...	...	1	1	...	101	C	Tube
A 519	1020 CW	G10200	70	...	...	1	2	...	101	C	Tube
A 519	1022 HR	G10220	50	...	...	1	1	...	101	C	Tube
A 519	1022 CW	G10220	70	...	...	1	2	...	101	C	Tube
A 519	1025 HR	G10250	55	...	...	1	1	...	101	C	Tube
A 519	1025 CW	G10250	75	...	...	1	2	...	101	C	Tube
A 519	1026 HR	G10260	55	...	...	1	1	...	101	C	Tube
A 519	1026 CW	G10260	75	...	...	1	2	...	101	C	Tube
A 521	Cl. CC	...	60	...	...	1	1	...	101	C	Forgings
A 521	Cl. CE	...	75	...	...	1	2	...	101	C	Forgings
SA-522	Type II	K71340	100	11A	1	...	...	101	...	8Ni	Forgings
SA-522	Type I	K81340	100	11A	1	...	...	101	...	9Ni	Forgings
SA-524	II	K02104	55	1	1	...	...	101	...	C–Mn–Si	Smls. pipe
SA-524	I	K02104	60	1	1	...	...	101	...	C–Mn–Si	Smls. pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-533	Type A, Cl. 1	K12521	80	3	3	...	...	101	...	Mn–0.5Mo	Plate
SA-533	Type A, Cl. 2	K12521	90	3	3	...	...	101	...	Mn–0.5Mo	Plate
SA-533	Type A, Cl. 3	K12521	100	11A	4	...	...	101	...	Mn–0.5Mo	Plate
SA-533	Type D, Cl. 1	K12529	80	3	3	...	...	101	...	Mn–0.5Mo–0.25Ni	Plate
SA-533	Type D, Cl. 2	K12529	90	3	3	...	...	101	...	Mn–0.5Mo–0.25Ni	Plate
SA-533	Type D, Cl. 3	K12529	100	11A	4	...	...	101	...	Mn–0.5Mo–0.25Ni	Plate
SA-533	Type B, Cl. 1	K12539	80	3	3	...	...	101	...	Mn–0.5Mo–0.5Ni	Plate
SA-533	Type B, Cl. 2	K12539	90	3	3	...	...	101	...	Mn–0.5Mo–0.5Ni	Plate
SA-533	Type B, Cl. 3	K12539	100	11A	4	...	...	101	...	Mn–0.5Mo–0.5Ni	Plate
SA-533	Type C, Cl. 1	K12554	80	3	3	...	...	101	...	Mn–0.5Mo–0.75Ni	Plate
SA-533	Type C, Cl. 2	K12554	90	3	3	...	...	101	...	Mn–0.5Mo–0.75Ni	Plate
SA-533	Type C, Cl. 3	K12554	100	11A	4	...	...	101	...	Mn–0.5Mo–0.75Ni	Plate
SA-537	Cl. 1	K12437	65	1	2	...	...	101	...	C–Mn–Si	Plate > $2^1/_2$ in.–4 in.
SA-537	Cl. 1	K12437	70	1	2	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. & under
SA-537	Cl. 2	K12437	70	1	3	...	...	101	...	C–Mn–Si	Plate > 4 in.–6 in., incl.
SA-537	Cl. 2	K12437	75	1	3	...	...	101	...	C–Mn–Si	Plate > $2^1/_2$ in.–4 in.
SA-537	Cl. 2	K12437	80	1	3	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. & under
SA-537	Cl. 3	K12437	70	1	3	...	...	101	...	C–Mn–Si	Plate > 4 in.
SA-537	Cl. 3	K12437	75	1	3	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. < $t \leq$ 4 in.
SA-537	Cl. 3	K12437	80	1	3	...	...	101	...	C–Mn–Si	Plate ≤ $2^1/_2$ in.
SA-541	1	K03506	70	1	2	...	...	101	...	C–Si	Forgings
SA-541	1A	...	70	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-541	11, Cl. 4	K11572	80	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Forgings
SA-541	3, Cl. 1	K12045	80	3	3	...	...	101	...	0.5Ni–0.5Mo–V	Forgings
SA-541	3, Cl. 2	K12045	90	3	3	...	...	101	...	0.5Ni–0.5Mo–V	Forgings
SA-541	2, Cl. 1	K12765	80	3	3	...	...	101	...	0.75Ni–0.5Mo–0.3Cr–V	Forgings
SA-541	2, Cl. 2	K12765	90	3	3	...	...	101	...	0.75Ni–0.5Mo–0.3Cr–V	Forgings
SA-541	22, Cl. 3	K21390	85	5C	1	...	...	102	...	2.25Cr–1Mo	Forgings
SA-541	22, Cl. 4	K21390	105	5C	4	...	...	102	...	2.25Cr–1Mo	Forgings
SA-541	22, Cl. 5	K21390	115	5C	5	...	...	102	...	2.25Cr–1Mo	Forgings
SA-541	3V	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Forgings
SA-541	22V	K31835	85	5C	1	...	...	...	...	2.25Cr–1Mo–V	Forgings
SA-542	B, Cl. 4a	K21590	85	5C	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	B, Cl. 4	K21590	85	5C	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	A, Cl. 4	K21590	85	5C	1	...	...	102	...	2.25Cr–1Mo	Plate

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-542	A, Cl. 4a	K21590	85	5C	1	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	A, Cl. 3	K21590	95	5C	3	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	B, Cl. 3	K21590	95	5C	3	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	A, Cl. 1	K21590	105	5C	4	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	B, Cl. 1	K21590	105	5C	4	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	B, Cl. 2	K21590	115	5C	5	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	A, Cl. 2	K21590	115	5C	5	...	...	102	...	2.25Cr–1Mo	Plate
SA-542	C, Cl. 4	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-542	C, Cl. 4a	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-542	C, Cl. 3	K31830	95	5C	3	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-542	C, Cl. 1	K31830	105	5C	4	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-542	C, Cl. 2	K31830	115	5C	5	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-542	D, Cl. 4a	K31835	85	5C	1	...	...	...	...	2.25Cr–1Mo–V	Plate
SA-543	B Cl. 3	K42339	90	11A	5	...	...	102	...	3Ni–1.75Cr–0.5Mo	Plate
SA-543	B Cl. 1	K42339	105	11A	5	...	...	102	...	3Ni–1.75Cr–0.5Mo	Plate
SA-543	B Cl. 2	K42339	115	11B	10	...	...	102	...	3Ni–1.75Cr–0.5Mo	Plate
SA-543	C Cl. 3	K42338	90	11A	5	...	...	102	...	2.75Ni–1.5Cr–0.5Mo	Plate
SA-543	C Cl. 1	K42338	105	11A	5	...	...	102	...	2.75Ni–1.5Cr–0.5Mo	Plate
SA-543	C Cl. 2	K42338	115	11B	10	...	...	102	...	2.75Ni–1.5Cr–0.5Mo	Plate
SA-553	II	K71340	100	11A	1	...	...	101	...	8Ni	Plate
SA-553	I	K81340	100	11A	1	...	...	101	...	9Ni	Plate
SA-556	A2	K01807	47	1	1	...	...	101	...	C	Smls. tube
SA-556	B2	K02707	60	1	1	...	...	101	...	C–Si	Smls. tube
SA-556	C2	K03006	70	1	2	...	...	101	...	C–Si	Smls. tube
SA-557	A2	K01807	47	1	1	...	...	101	...	C	E.R.W. tube
SA-557	B2	K03007	60	1	1	...	...	101	...	C	E.R.W. tube
SA-557	C2	K03505	70	1	2	...	...	101	...	C–Mn	E.R.W. tube
SA-562	...	K11224	55	1	1	...	...	101	...	C–Mn–Ti	Plate
A 570	30	K02502	49	...	...	1	1	...	101	C	Sheet & strip
A 570	33	K02502	52	...	...	1	1	...	101	C	Sheet & strip
A 570	36	K02502	53	...	...	1	1	...	101	C	Sheet & strip
A 570	40	K02502	55	...	...	1	1	...	101	C	Sheet & strip
A 570	45	K02507	60	...	...	1	1	...	101	C	Sheet & strip

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 570	50	K02507	65	...	...	1	1	...	101	C	Sheet & strip
A 572	42	...	60	...	...	1	1	...	101	C–Mn–Si	Plate & shapes
A 572	50	...	65	...	...	1	1	...	101	C–Mn–Si	Plate & shapes
A 572	60	...	75	...	...	1	2	...	101	C–Mn–Si	Plate & shapes
A 573	...	...	...	...	...	1	1	...	101	C	Plate
A 575	...	...	...	...	...	1	1	...	101	C	Bar
A 576	...	...	...	...	...	1	1	...	101	C	Bar
SA-587	...	K11500	48	1	1	...	...	101	...	C	E.R.W. pipe
A 588	A, a	K11430	63	...	...	3	1	...	101	Mn–0.5Cr–0.3Cu–Si–V	Plate & bar
A 588	A, b	K11430	67	...	...	3	1	...	101	Mn–0.5Cr–0.3Cu–Si–V	Plate & bar
A 588	A, c	K11430	70	...	...	3	1	...	101	Mn–0.5Cr–0.3Cu–Si–V	Plate & shapes
A 588	B, a	K12043	63	...	...	3	1	...	101	Mn–0.6Cr–0.3Cu–Si–V	Plate & bar
A 588	B, b	K12043	67	...	...	3	1	...	101	Mn–0.6Cr–0.3Cu–Si–V	Plate & bar
A 588	B, c	K12043	70	...	...	3	1	...	101	Mn–0.6Cr–0.3Cu–Si–V	Plate & shapes
SA-592	F	K11576	105	11B	3	...	...	101	...	0.75Ni–0.5Cr–0.5Mo–V	Forgings, $2^1/_2$ in.–4 in.
SA-592	F	K11576	115	11B	3	...	...	101	...	0.75Ni–0.5Cr–0.5Mo–V	Forgings, $2^1/_2$ in. & under
SA-592	E	K11695	105	11B	2	...	...	102	...	1.75Cr–0.5Mo–Cu	Forgings, $2^1/_2$ in.–4 in.
SA-592	E	K11695	115	11B	2	...	...	102	...	1.75Cr–0.5Mo–Cu	Forgings, $2^1/_2$ in. & under
SA-592	A	K11856	105	11B	1	...	...	101	...	0.5Cr–0.25Mo–Si	Forgings, $2^1/_2$ in.–4 in.
SA-592	A	K11856	115	11B	1	...	...	101	...	0.5Cr–0.25Mo–Si	Forgings, $2^1/_2$ in. & under
A 611	A	G10170	42	...	...	1	1	...	101	C	Sheet
A 611	B	G10170	45	...	...	1	1	...	101	C	Sheet
A 611	C	G10170	48	...	...	1	1	...	101	C	Sheet
SA-612	...	K02900	81	10C	1	...	...	101	...	C–Mn–Si	Plate > $^1/_2$ in.–1 in.
SA-612	...	K02900	83	10C	1	...	...	101	...	C–Mn–Si	Plate, $^1/_2$ in. & under
A 618	II, b	K12609	67	...	...	1	2	...	101	Mn–Cu–V	Tube > $^3/_4$ in.–$1^1/_2$ in.
A 618	II, a	K12609	70	...	...	1	2	...	101	Mn–Cu–V	Tube, $^3/_4$ in. & under
A 618	III	K12700	65	...	...	1	1	...	101	Mn–V	Tube
SA-620	...	K00040	40	1	1	...	...	101	...	C	Sheet

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 633	A	K01802	63	...	...	1	1	...	101	Mn–Cb	Plate & shapes
A 633	C b	K12000	65	...	...	1	1	...	101	Mn–Cb	Plate > $2^1/_2$ in.–4 in., shapes
A 633	C a	K12000	70	...	...	1	2	...	101	Mn–Cb	Plate to $2^1/_2$ in., shapes
A 633	D b	K12037	65	...	...	1	1	...	101	Mn–Cr–Ni–Cu	Plate > $2^1/_2$ in.–4 in., shapes
A 633	D a	K12037	70	...	...	1	2	...	101	Mn–Cr–Ni–Cu	Plate to $2^1/_2$ in., shapes
A 633	E	K12202	80	...	...	1	3	...	101	C–Mn–Si–V	Plate & shapes
SA-645	...	K41583	95	11A	2	...	...	101	...	5Ni–0.25Mo	Plate
SA-660	WCA	J02504	60	1	1	...	...	101	...	C–Si	Centrifugal cast pipe
SA-660	WCC	J02505	70	1	2	...	...	101	...	C–Mn–Si	Centrifugal cast pipe
SA-660	WCB	J03003	70	1	2	...	...	101	...	C–Si	Centrifugal cast pipe
SA-662	A	K01701	58	1	1	...	...	101	...	C–Mn–Si	Plate
SA-662	C	K02007	70	1	2	...	...	101	...	C–Mn–Si	Plate
SA-662	B	K02203	65	1	1	...	...	101	...	C–Mn–Si	Plate
A 663	...	...	...	...	...	1	1	...	101	C	Bar
SA-666	201	S20100	95	8	3	...	...	102	...	17Cr–4Ni–6Mn	Plate, sheet, & strip
SA-666	XM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Plate, sheet, & strip
SA-666	302	S30200	75	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-666	304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-666	304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Plate, sheet, & strip
SA-666	304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Plate, sheet, & strip
SA-666	304LN	S30453	80	8	1	...	...	102	...	18Cr–8Ni–N	Plate, sheet, & strip
SA-666	316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Plate, sheet, & strip
SA-666	316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Plate, sheet, & strip
SA-666	316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Plate, sheet, & strip
A 668	Cl. B	G10200	60	...	...	1	1	...	101	C	Forgings
A 668	Cl. C	G10250	66	...	...	1	1	...	101	C	Forgings
A 668	Cl. D	G10300	75	...	...	1	2	...	101	C–Mn	Forgings
A 668	Cl. F b	...	85	...	...	1	3	...	101	C–Mn	Forgings > 4 in.–10 in.
A 668	Cl. F a	...	90	...	...	1	3	...	101	C–Mn	Forgings, to 4 in.
A 668	Cl. K b	...	100	...	...	4	3	...	101	C	Forgings > 7 in.–10 in.
A 668	Cl. K a	...	105	...	...	4	3	...	101	C	Forgings, to 7 in.
A 668	Cl. L c	...	110	...	...	4	3	...	101	C	Forgings > 7 in.–10 in.

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
A 668	Cl. L b	...	115	...	...	4	3	...	101	C	Forgings > 4 in.–7 in.
A 668	Cl. L a	...	125	...	...	4	3	...	101	C	Forgings, to 4 in.
SA-671	CC60	K02100	60	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CE55	K02202	55	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CD70	K12437	70	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CD80	K12437	80	1	3	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CB60	K02401	60	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-671	CE60	K02402	60	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CC65	K02403	65	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CC70	K02700	70	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CB65	K02800	65	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-671	CA55	K02801	55	1	1	...	...	101	...	C	Fusion welded pipe
SA-671	CK75	K02803	75	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-671	CB70	K03101	70	1	2	...	...	101	...	C–Si	Fusion welded pipe
SA-672	A45	K01700	45	1	1	...	...	101	...	C	Fusion welded pipe
SA-672	C55	K01800	55	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-672	B55	K02001	55	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-672	C60	K02100	60	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	A50	K02200	50	1	1	...	...	101	...	C	Fusion welded pipe
SA-672	E55	K02202	55	1	1	...	...	101	...	C	Fusion welded pipe
SA-672	D70	K12437	70	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	D80	K12437	80	1	3	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	B60	K02401	60	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-672	E60	K02402	60	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	C65	K02403	65	1	1	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	C70	K02700	70	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	B65	K02800	65	1	1	...	...	101	...	C–Si	Fusion welded pipe
SA-672	A55	K02801	55	1	1	...	...	101	...	C	Fusion welded pipe
SA-672	N75	K02803	75	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-672	B70	K03101	70	1	2	...	...	101	...	C–Si	Fusion welded pipe
SA-672	L65	K11820	65	3	1	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-672	L70	K12020	70	3	2	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-672	H75	K12021	75	3	2	...	...	101	...	Mn–0.5Mo	Fusion welded pipe
SA-672	H80	K12022	80	3	3	...	...	101	...	Mn–0.5Mo	Fusion welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-672	L75	K12320	75	3	2	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-672	J100	K12521	100	11A	4	...	...	101	...	Mn–0.5Mo	Fusion welded pipe
SA-672	J80	K12554	80	3	3	...	...	101	...	Mn–0.5Mo–0.75Ni	Fusion welded pipe
SA-672	J90	K12554	90	3	3	...	...	101	...	Mn–0.5Mo–0.75Ni	Fusion welded pipe
SA-675	45	...	45	1	1	...	...	101	...	C	Bar
SA-675	50	...	50	1	1	...	...	101	...	C	Bar
SA-675	55	...	55	1	1	...	...	101	...	C	Bar
SA-675	60	...	60	1	1	...	...	101	...	C	Bar
SA-675	65	...	65	1	1	...	...	101	...	C	Bar
SA-675	70	...	70	1	2	...	...	101	...	C	Bar
A 675	75	...	75	...	...	1	2	...	101	C	Bar
SA-688	XM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Welded tube
SA-688	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Welded tube
SA-688	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Welded tube
SA-688	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Welded tube
SA-688	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Welded tube
SA-688	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded tube
SA-688	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded tube
SA-688	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded tube
SA-688	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded tube
SA-691	CMSH–70	K12437	65	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe > $2^1/_2$–4 in.
SA-691	CMSH–70	K12437	70	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe ≤ $2^1/_2$ in.
SA-691	CMSH–80	K12437	75	1	3	...	...	101	...	C–Mn–Si	Fusion welded pipe > $2^1/_2$–4 in.
SA-691	CMSH–80	K12437	80	1	3	...	...	101	...	C–Mn–Si	Fusion welded pipe ≤ $2^1/_2$ in.
SA-691	CMS–75	K02803	75	1	2	...	...	101	...	C–Mn–Si	Fusion welded pipe
SA-691	1CR, Cl. 1	K11757	55	4	1	...	...	102	...	1Cr–0.5Mo	Fusion welded pipe
SA-691	1CR, Cl. 2	K11757	65	4	1	...	...	102	...	1Cr–0.5Mo	Fusion welded pipe
SA-691	1.25CR, Cl. 1	K11789	60	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Fusion welded pipe
SA-691	1.25CR, Cl. 2	K11789	75	4	1	...	...	102	...	1.25Cr–0.5Mo–Si	Fusion welded pipe
SA-691	CM–65	K11820	65	3	1	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-691	CM–70	K12020	70	3	2	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-691	0.5CR, Cl. 1	K12143	55	3	1	...	...	101	...	0.5Cr–0.5Mo	Fusion welded pipe
SA-691	0.5CR, Cl. 2	K12143	70	3	2	...	...	101	...	0.5Cr–0.5Mo	Fusion welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-691	CM–75	K12320	75	3	2	...	...	101	...	C–0.5Mo	Fusion welded pipe
SA-691	2.25CR, Cl. 1	K21590	60	5A	1	...	...	102	...	2.25Cr–1Mo	Fusion welded pipe
SA-691	2.25CR, Cl. 2	K21590	75	5A	1	...	...	102	...	2.25Cr–1Mo	Fusion welded pipe
SA-691	3CR, Cl. 1	K31545	60	5A	1	...	...	102	...	3Cr–1Mo	Fusion welded pipe
SA-691	3CR, Cl. 2	K31545	75	5A	1	...	...	102	...	3Cr–1Mo	Fusion welded pipe
SA-691	5CR, Cl. 1	K41545	60	5B	1	...	...	102	...	5Cr–0.5Mo	Fusion welded pipe
SA-691	5CR, Cl. 2	K41545	75	5B	1	...	...	102	...	5Cr–0.5Mo	Fusion welded pipe
A 691	9CR, Cl. 2	...	85	...	...	5B	2	...	...	9Cr-1Mo-V	Fusion welded pipe
A 694	F42	K03014	60	...	...	1	1	...	101	C–Mn	Forgings
A 694	F46	K03014	60	...	...	1	1	...	101	C–Mn	Forgings
A 694	F52	K03014	66	...	...	1	1	...	101	C–Mn	Forgings
A 694	F56	K03014	68	...	...	1	2	...	101	C–Mn	Forgings
A 694	F60	K03014	75	...	...	1	2	...	101	C–Mn	Forgings
A 694	F65	K03014	77	...	...	1	2	...	101	C–Mn	Forgings
A 694	F70	K03014	82	...	...	1	3	...	101	C–Mn	Forgings
SA-695	Type B, Gr. 35	K03504	60	1	1	...	...	101	...	C–Mn–Si	Bar
SA-695	Type B, Gr. 40	K03504	70	1	2	...	...	101	...	C–Mn–Si	Bar
SA-696	B	K03200	60	1	1	...	...	101	...	C–Mn–Si	Bar
SA-696	C	K03200	70	1	2	...	...	101	...	C–Mn–Si	Bar
A 714	Gr. V, Tp. E	K22035	65	...	...	9A	1	...	102	2Ni–1Cu	Smls. & welded pipe
A 714	Gr. V	K22035	65	...	...	9A	1	...	102	2Ni–1Cu	Smls. & welded pipe
SA-724	A	K11831	90	1	4	...	...	101	...	C–Mn–Si	Plate
SA-724	B	K12031	95	1	4	...	...	101	...	C–Mn–Si	Plate
SA-724	C	K12037	90	1	4	...	...	101	...	C–Mn–Si	Plate
SA-727	...	K02506	60	1	1	...	...	101	...	C–Mn–Si	Forgings
SA-731	S41500	S41500	115	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Smls. & welded pipe
SA-731	TP439	S43035	60	7	2	...	...	102	...	18Cr–Ti	Smls. & welded pipe
SA-731	18Cr–2Mo	S44400	60	7	2	...	...	102	...	18Cr–2Mo	Smls. & welded pipe
SA-731	TPXM–33	S44626	65	10I	1	...	...	102	...	27Cr–1Mo–Ti	Smls. & welded pipe
SA-731	TPXM–27	S44627	65	10I	1	...	...	102	...	27Cr–1Mo	Smls. & welded pipe
SA-731	S44660	S44660	85	10K	1	...	...	102	...	26Cr–3Ni–3Mo	Smls. & welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-731	S44700	S44700	80	10J	1	...	...	102	...	29Cr–4Mo	Smls. & welded pipe
SA-731	S44800	S44800	80	10K	1	...	...	102	...	29Cr–4Mo–2Ni	Smls. & welded pipe
SA-737	B	K12001	70	1	2	...	...	101	...	C–Mn–Si–Cb	Plate
SA-737	C	K12202	80	1	3	...	...	101	...	C–Mn–Si–V	Plate
SA-738	A	K12447	75	1	2	...	...	101	...	C–Mn–Si	Plate
SA-738	B	K12001	85	1	3	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. & under
SA-738	C	...	70	1	3	...	...	101	...	C–Mn–Si	Plate > 4 in.–6 in., incl.
SA-738	C	...	75	1	3	...	...	101	...	C–Mn–Si	Plate > $2^1/_2$ in.–4 in.
SA-738	C	...	80	1	3	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. & under
SA-739	B11	K11797	70	4	1	...	...	102	...	1.25Cr–0.5Mo	Bar
SA-739	B22	K21390	75	5A	1	...	...	102	...	2.25Cr–1Mo	Bar
SA-765	I	K03046	60	1	1	...	...	101	...	C–Mn–Si	Forgings
SA-765	II	K03047	70	1	2	...	...	101	...	C–Mn–Si	Forgings
SA-765	III	K32026	70	9B	1	...	...	101	...	3.5Ni	Forgings
SA-789	S31200	S31200	100	10H	1	...	...	102	...	25Cr–6Ni–Mo–N	Smls. & welded tube
SA-789	S31260	S31260	100	10H	1	...	...	102	...	25Cr–6.5Ni–3Mo–N	Smls. & welded tube
SA-789	S31500	S31500	92	10H	1	...	...	102	...	18Cr–5Ni–3Mo–N	Smls. & welded tube
SA-789	S31803	S31803	90	10H	1	...	...	102	...	22Cr–5Ni–3Mo–N	Smls. & welded tube
SA-789	S32304	S32304	87	10H	1	...	...	102	...	23Cr–4Ni–Mo–Cu–N	Smls. & welded tube
SA-789	S32550	S32550	110	10H	1	...	...	102	...	25Cr–5Ni–3Mo–2Cu	Smls. & welded tube
SA-789	S32750	S32750	116	10H	1	...	...	102	...	25Cr–7Ni–4Mo–N	Smls. & welded tube
SA-789	S32900	S32900	90	10H	1	...	...	102	...	26Cr–4Ni–Mo	Smls. & welded tube
SA-789	S32950	S32950	100	10H	1	...	...	102	...	26Cr–4Ni–Mo–N	Smls. & welded tube
SA-789	S32760	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Smls. & welded tube
SA-790	S31200	S31200	100	10H	1	...	...	102	...	25Cr–6Ni–Mo–N	Smls. & welded pipe
SA-790	S31260	S31260	100	10H	1	...	...	102	...	25Cr–6.5Ni–3Mo–N	Smls. & welded pipe
SA-790	S31500	S31500	92	10H	1	...	...	102	...	18Cr–5Ni–3Mo–N	Smls. & welded pipe
SA-790	S31803	S31803	90	10H	1	...	...	102	...	22Cr–5Ni–3Mo–N	Smls. & welded pipe
SA-790	S32304	S32304	87	10H	1	...	...	102	...	23Cr–4Ni–Mo–Cu–N	Smls. & welded pipe
SA-790	S32550	S32550	110	10H	1	...	...	102	...	25Cr–5Ni–3Mo–2Cu	Smls. & welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-790	S32750	S32750	116	10H	1	...	...	102	...	25Cr–7Ni–4Mo–N	Smls. & welded tube
SA-790	S32900	S32900	90	10H	1	...	...	102	...	26Cr–4Ni–Mo	Smls. & welded pipe
SA-790	S32950	S32950	100	10H	1	...	...	102	...	26Cr–4Ni–Mo–N	Smls. & welded pipe
SA-790	S32760	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Smls. & welded tube
SA-803	TP439	S43035	70	7	2	...	...	102	...	17Cr–Ti	Welded tube
SA-803	26–3–3	S44660	85	10K	1	...	...	102	...	26Cr–3Ni–3Mo	Welded tube
SA-813	TPXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Welded pipe
SA-813	TPXM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Welded pipe
SA-813	TPXM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Welded pipe
SA-813	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Welded pipe
SA-813	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Welded pipe
SA-813	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Welded pipe
SA-813	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Welded pipe
SA-813	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Welded pipe
SA-813	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Welded pipe
SA-813	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Welded pipe
SA-813	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Welded pipe
SA-813	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Welded pipe
SA-813	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Welded pipe
SA-813	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Welded pipe
SA-813	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded pipe
SA-813	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded pipe
SA-813	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Welded pipe
SA-813	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded pipe
SA-813	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Welded pipe
SA-813	TP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Welded pipe
SA-813	TP317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Welded pipe
SA-813	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded pipe
SA-813	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Welded pipe
SA-813	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-813	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-813	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-813	TP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Welded pipe
SA-813	TPXM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Welded pipe
SA-814	TPXM–19	S20910	100	8	3	...	...	102	...	22Cr–13Ni–5Mn	Cold worked welded pipe
SA-814	TPXM–11	S21904	90	8	3	...	...	102	...	21Cr–6Ni–9Mn	Cold worked welded pipe
SA-814	TPXM–29	S24000	100	8	3	...	...	102	...	18Cr–3Ni–12Mn	Cold worked welded pipe
SA-814	TP304	S30400	75	8	1	...	...	102	...	18Cr–8Ni	Cold worked welded pipe
SA-814	TP304L	S30403	70	8	1	...	...	102	...	18Cr–8Ni	Cold worked welded pipe
SA-814	TP304H	S30409	75	8	1	...	...	102	...	18Cr–8Ni	Cold worked welded pipe
SA-814	TP304N	S30451	80	8	1	...	...	102	...	18Cr–8Ni–N	Cold worked welded pipe
SA-814	TP304LN	S30453	75	8	1	...	...	102	...	18Cr–8Ni–N	Cold worked welded pipe
SA-814	S30815	S30815	87	8	2	...	...	102	...	21Cr–11Ni–N	Cold worked welded pipe
SA-814	TP309S	S30908	75	8	2	...	...	102	...	23Cr–12Ni	Cold worked welded pipe
SA-814	TP309Cb	S30940	75	8	2	...	...	102	...	23Cr–12Ni–Cb	Cold worked welded pipe
SA-814	TP310S	S31008	75	8	2	...	...	102	...	25Cr–20Ni	Cold worked welded pipe
SA-814	TP310Cb	S31040	75	8	2	...	...	102	...	25Cr–20Ni–Cb	Cold worked welded pipe
SA-814	S31254	S31254	94	8	4	...	...	102	...	20Cr–18Ni–6Mo	Cold worked welded pipe
SA-814	TP316	S31600	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Cold worked welded pipe
SA-814	TP316L	S31603	70	8	1	...	...	102	...	16Cr–12Ni–2Mo	Cold worked welded pipe
SA-814	TP316H	S31609	75	8	1	...	...	102	...	16Cr–12Ni–2Mo	Cold worked welded pipe
SA-814	TP316N	S31651	80	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Cold worked welded pipe
SA-814	TP316LN	S31653	75	8	1	...	...	102	...	16Cr–12Ni–2Mo–N	Cold worked welded pipe
SA-814	TP317	S31700	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Cold worked welded pipe
SA-814	TP317L	S31703	75	8	1	...	...	102	...	18Cr–13Ni–3Mo	Cold worked welded pipe
SA-814	TP321	S32100	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Cold worked welded pipe
SA-814	TP321H	S32109	75	8	1	...	...	102	...	18Cr–10Ni–Ti	Cold worked welded pipe
SA-814	TP347	S34700	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Cold worked welded pipe
SA-814	TP347H	S34709	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Cold worked welded pipe
SA-814	TP348	S34800	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Cold worked welded pipe
SA-814	TP348H	S34809	75	8	1	...	...	102	...	18Cr–10Ni–Cb	Cold worked welded pipe
SA-814	TPXM–15	S38100	75	8	1	...	...	102	...	18Cr–18Ni–2Si	Cold worked welded pipe
SA-815	S31803	S31803	90	10H	1	...	...	102	...	22Cr–5Ni–3Mo–N	Fittings
SA-815	S41500	S41500	110	6	4	...	...	102	...	13Cr–4.5Ni–Mo	Fittings

QW/QB-422 FERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
Grouping of Base Metals for Qualification

Spec. No.	Type or Grade	UNS No.	Minimum Specified Tensile, ksi	Welding				Brazing		Nominal Composition	Product Form
				P-No.	Group No.	S-No.	Group No.	P-No.	S-No.		
SA-815	S32760	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Fittings
SA-832	21V	K31830	85	5C	1	...	...	102	...	3Cr–1Mo–V–Ti–B	Plate
SA-832	22V	K31835	85	5C	1	...	...	...	...	2.25Cr–1Mo–V	Plate
SA-836	...	...	55	1	1	...	...	101	...	C–Si–Ti	Forgings
SA-841	...	...	65	10C	1	...	...	101	...	C–Mn–Si	Plate > $2^1/_2$ in.
SA-841	...	...	70	10C	1	...	...	101	...	C–Mn–Si	Plate, $2^1/_2$ in. & under
A 890	CD3MWCuN	J93380	100	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Castings
A 928	...	S32760	109	...	...	10H	1	...	102	25Cr–8Ni–3Mo–W–Cu–N	Welded pipe
API 5L	A25, Cl. I	...	45	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	A25, Cl. II	...	45	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	A	...	48	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	B	...	60	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X42	...	60	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X46	...	63	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X52	...	66	...	...	1	1	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X56	...	71	...	...	1	2	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X60	...	75	...	...	1	2	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X65	...	77	...	...	1	2	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X70	...	82	...	...	1	3	...	101	C–Mn	Smls. & welded pipe & tubes
API 5L	X80	...	90	...	...	1	4	...	101	C–Mn	Smls. & welded pipe & tubes
MSS SP-75	WPHY-42	...	60	...	...	1	1	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-46	...	63	...	...	1	1	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-52	...	66	...	...	1	1	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-56	...	71	...	...	1	2	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-60	...	75	...	...	1	2	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-65	...	77	...	...	1	2	...	101	C–Mn	Smls./welded fittings
MSS SP-75	WPHY-70	...	82	...	...	1	3	...	101	C–Mn	Smls./welded fittings
SA/CSA-G 40.21	Gr. 38W	...	60	1	1	...	...	101	...	C–Mn–Si	Plate, bar, & shapes
SA/CSA-G 40.21	Gr. 44W	...	60	1	1	...	...	101	...	C–Mn–Si	Plate, bar, & shapes

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
B 16	C3600	...	48	...	...	...	107	65Cu–Zn–3Pb	Rod ≤ 1 in.
B 16	C3600	...	44	...	...	...	107	65Cu–Zn–3Pb	Rod > 1-2 in., incl.
B 16	C3600	...	40	...	...	...	107	65Cu–Zn–3Pb	Rod > 2 in., incl.
B 16	C3600	...	44	...	...	...	107	65Cu–Zn–3Pb	Bar ≤ 1 in.
B 16	C3600	...	40	...	...	...	107	65Cu–Zn–3Pb	Bar > 1 in.
B 26	A24430	...	17	...	21	...	104	Al–Si	Castings
B 26	A03560	...	25	...	21	...	104	Al–Si	Castings
B 26	A03560	...	30	...	21	...	104	Al–Si	Castings
SB-42	C10200	...	30	31	...	107	...	99.95Cu–P	Smls. pipe
SB-42	C12000	...	30	31	...	107	...	99.9Cu–P	Smls. pipe
SB-42	C12200	...	30	31	...	107	...	99.9Cu–P	Smls. pipe
SB-43	C23000	...	40	32	...	107	...	85Cu–15Zn	Smls. pipe
SB-61	C92200	...	30	...	...	107	...	88Cu–Sn–Zn–Pb	Castings
SB-62	C83600	...	28	...	...	107	...	85Cu–5Sn–5Zn–5Pb	Castings
B 68	C10200	102	30	...	31	...	107	99.95Cu–P	Tube
B 68	C12000	120	30	...	31	...	107	99.9Cu–P	Tube
B 68	C12200	122	30	...	31	...	107	99.9Cu–P	Tube
SB-75	C10200	...	30	31	...	107	...	99.95Cu–P	Smls. tube
SB-75	C12000	...	30	31	...	107	...	99.9Cu–P	Smls. tube
SB-75	C12200	...	30	31	...	107	...	99.9Cu–P	Smls. tube
B 85	...	...	...	...	31	...	107	...	Die castings
B 88	C10200	102	30	...	31	...	107	99.95Cu–P	Tube
B 88	C12000	120	30	...	31	...	107	99.9Cu–P	Tube
B 88	C12200	122	30	...	31	...	107	99.9Cu–P	Tube
SB-96	C65500	...	50	33	...	107	...	97Cu–3.3Si	Plate, sht, strip, & bar
SB-98	C65100	...	40	33	...	107	...	98.5Cu–1.5Si	Rod, bar, & shapes
SB-98	C65500	...	52	33	...	107	...	97Cu–3Si	Rod, bar, & shapes
SB-98	C66100	...	52	33	...	107	...	94Cu–3Si	Rod, bar, & shapes

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-111	C10200	...	30	31	...	107	...	99.95Cu–P	Smls. tube
SB-111	C12000	...	30	31	...	107	...	99.9Cu–P	Smls. tube
SB-111	C12200	...	30	31	...	107	...	99.9Cu–P	Smls. tube
SB-111	C14200	...	30	31	...	107	...	99.4Cu–As–P	Smls. tube
SB-111	C19200	...	38	31	...	107	...	99.7Cu–Fe–P	Smls. tube
SB-111	C23000	...	40	32	...	107	...	85Cu–15Zn	Smls. tube
SB-111	C28000	...	50	32	...	107	...	60Cu–40Zn	Smls. tube
SB-111	C44300	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06As	Smls. tube
SB-111	C44400	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06Sb	Smls. tube
SB-111	C44500	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06P	Smls. tube
SB-111	C60800	...	50	35	...	108	...	95Cu–5Al	Smls. tube
SB-111	C68700	...	50	32	...	108	...	78Cu–20Zn–2Al	Smls. tube
SB-111	C70400	...	38	34	...	107	...	95Cu–5Ni	Smls. tube
SB-111	C70600	...	40	34	...	107	...	90Cu–10Ni	Smls. tube
SB-111	C71000	...	45	34	...	107	...	80Cu–20Ni	Smls. tube
SB-111	C71500	...	52	34	...	107	...	70Cu–30Ni	Smls. tube
SB-111	C71640	...	63	34	...	107	...	66Cu–30Ni–2Fe–2Mn	Smls. tube
SB-111	C72200	...	45	34	...	107	...	80Cu–16Ni–0.75Fe–0.5Cr	Smls. tube
SB-127	N04400	...	70	42	...	110	...	67Ni–30Cu	Plate, sheet, & strip
SB-135	C23000	...	40	32	...	107	...	85Cu–15Zn	Smls. tube
SB-148	C95200	...	65	35	...	108	...	88Cu–9Al-3Fe	Castings
SB-148	C95400	...	75	35	...	108	...	85Cu–11Al-4Fe	Castings
B 148	C95300	...	65	...	35	...	108	89Cu–10Al–1Fe	Castings
B 148	C95500	...	90	...	35	...	108	82Cu–11Al–4Fe–3Mn	Castings
B 148	C95600	...	60	...	35	...	108	90Cu–7Al–3Si	Castings
SB-150	C61400	...	70	35	...	108	...	90Cu–7Al–3Fe	Rod & bar
SB-150	C62300	...	75	35	...	108	...	88Cu–9Al–3Fe	Rod (round)
SB-150	C63000	...	85	35	...	108	...	81Cu–10Al–5Ni–3Fe	Rod & bar
SB-150	C64200	...	70	35	...	108	...	91Cu–7Al–2Si	Rod & bar

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-151	C70600	...	38	34	...	107	...	90Cu–10Ni	Rod & bar
SB-152	C10200	...	30	31	...	107	...	99.95Cu–P	Plt, sht, strip, & bar
SB-152	C10400	...	30	31	...	107	...	99.95Cu + Ag	Plt, sht, strip, & bar
SB-152	C10500	...	30	31	...	107	...	99.95Cu + Ag	Plt, sht, strip, & bar
SB-152	C10700	...	30	31	...	107	...	99.95Cu + Ag	Plt, sht, strip, & bar
SB-152	C11000	...	30	31	...	107	...	99.90Cu	Plt, sht, strip, & bar
SB-152	C12200	...	30	31	...	107	...	99.9Cu–P	Plt, sht, strip, & bar
SB-152	C12300	...	30	31	...	107	...	99.9Cu–P	Plt, sht, strip, & bar
SB-152	C12500	...	30	31	...	107	...	99.88Cu	Plt, sht, strip, & bar
SB-152	C14200	...	30	31	...	107	...	99.4Cu–As–P	Plt, sht, strip, & bar
SB-160	N02200	...	55	41	...	110	...	99.0Ni	Rod & bar
SB-160	N02201	...	50	41	...	110	...	99.0Ni–Low C	Rod & bar
SB-161	N02200	...	55	41	...	110	...	99.0Ni	Smls. pipe & tube
SB-161	N02201	...	50	41	...	110	...	99.0Ni–Low C	Smls. pipe & tube
SB-162	N02200	...	55	41	...	110	...	99.0Ni	Plate, sheet, & strip
SB-162	N02201	...	50	41	...	110	...	99.0Ni–Low C	Plate, sheet, & strip
SB-163	N02200	...	55	41	...	110	...	99.0Ni	Smls. tube
SB-163	N02201	...	50	41	...	110	...	99.0Ni–Low C	Smls. tube
SB-163	N04400	...	70	42	...	110	...	67Ni–30Cu	Smls. tube
SB-163	N06600	...	80	43	...	111	...	72Ni–15Cr–8Fe	Smls. tube
SB-163	N06690	...	85	43	...	111	...	58Ni–29Cr–9Fe	Smls. tube
SB-163	N08800	...	75	45	...	111	...	33Ni–42Fe–21Cr	Smls. tube
SB-163	N08810	...	65	45	...	111	...	33Ni–42Fe–21Cr	Smls. tube
SB-163	N08811	...	65	45	...	...	...	33Ni–42Fe–21Cr-1 (Al+Ti)	Smls. tube
SB-163	N08825	...	85	45	...	111	...	42Ni–21.5Cr–3Mo–2.3Cu	Smls. tube
SB-164	N04400	...	70	42	...	110	...	67Ni–30Cu	Rod, bar, & wire
SB-164	N04405	...	70	42	...	110	...	67Ni–30Cu	Rod, bar, & wire
SB-165	N04400	...	70	42	...	110	...	67Ni–30Cu	Smls. pipe & tube
SB-166	N06600	...	80	43	...	111	...	72Ni–15Cr–8Fe	Rod, bar, & wire
SB-166	N06690	...	85	43	...	111	...	58Ni–29Cr–9Fe	Rod, bar, & wire
SB-167	N06600	...	75	43	...	111	...	72Ni–15Cr–8Fe	Smls. pipe & tube

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-167	N06690	...	75	43	...	111	...	58Ni–29Cr–9Fe	Smls. pipe & tube
SB-168	N06600	...	80	43	...	111	...	72Ni–15Cr–8Fe	Plate, sheet, & strip
SB-168	N06690	...	85	43	...	111	...	58Ni–29Cr–9Fe	Plate, sheet, & strip
SB-169	C61400	...	65	35	...	108	...	90Cu–7Al–3Fe	Plt, sht, strip, & bar
SB-171	C36500	...	40	32	...	107	...	60Cu–39Zn–Pb	Plate & sheet
SB-171	C44300	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06As	Plate & sheet
SB-171	C44400	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06Sb	Plate & sheet
SB-171	C44500	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06P	Plate & sheet
SB-171	C46400	...	50	32	...	107	...	60Cu–39Zn–Sn	Plate & sheet
SB-171	C46500	...	50	32	...	107	...	60Cu–39Zn–As	Plate & sheet
SB-171	C61400	...	65	35	...	108	...	90Cu–7Al–3Fe	Plate & sheet > 2–5 in., incl.
SB-171	C61400	...	70	35	...	108	...	90Cu–7Al–3Fe	Plate & sheet ≤ 2 in.
SB-171	C63000	...	80	35	...	108	...	81Cu–10Al–5Ni–3Fe	Plate & sheet > 3½–5 in., incl.
SB-171	C63000	...	85	35	...	108	...	81Cu–10Al–5Ni–3Fe	Plate & sheet > 2–3.5 in., incl.
SB-171	C63000	...	90	35	...	108	...	81Cu–10Al–5Ni–3Fe	Plate & sheet ≤ 2 in.
SB-171	C70600	...	40	34	...	107	...	90Cu–10Ni	Plate & sheet
SB-171	C71500	...	45	34	...	107	...	70Cu–30Ni	Plate & sheet > 2.5–5 in., incl.
SB-171	C71500	...	50	34	...	107	...	70Cu–30Ni	Plate & sheet ≤ 2.5 in.
SB-187	C10200	060	30	31	...	...	...	99.95Cu–P	Rod & bar
SB-187	C11000	060	30	31	...	...	...	99.9Cu	Rod & bar
SB-209	A91060	1060	8	21	...	104	...	99.6Al	Plate & sheet
SB-209	A91100	1100	11	21	...	104	...	99.0Al	Plate & sheet
SB-209	A93003	3003	14	21	...	104	...	Al–Mn–Mg	Plate & sheet
SB-209	A93004	3004	22	22	...	104	...	Al–Mn–Mg	Plate & sheet
SB-209	A95052	5052	25	22	...	105	...	Al–2.5Mg	Plate & sheet
SB-209	A95083	5083	36	25	...	105	...	Al–4.4Mg–Mn	Plate & sheet > 7–8 in., incl.
SB-209	A95083	5083	37	25	...	105	...	Al–4.4Mg–Mn	Plate & sheet > 5–7 in., incl.
SB-209	A95083	5083	38	25	...	105	...	Al–4.4Mg–Mn	Plate & sheet > 3–5 in., incl.
SB-209	A95083	5083	39	25	...	105	...	Al–4.4Mg–Mn	Plate & sheet > 1.5–3 in., incl.
SB-209	A95083	5083	40	25	...	105	...	Al–4.4Mg–Mn	Plate & sheet > 0.05–1.5 in., incl.
SB-209	A95086	5086	34	25	...	105	...	Al–4.0Mg–Mn	Plate & sheet > 2–3 in., incl.
SB-209	A95086	5086	35	25	...	105	...	Al–4.0Mg–Mn	Plate & sheet > 0.05–2 in., incl.

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-209	A95154	5154	30	22	...	105	...	Al–3.5Mg	Plate & sheet
SB-209	A95254	5254	30	22	...	105	...	Al–3.5Mg	Plate & sheet
SB-209	A95454	5454	31	22	...	105	...	Al–2.7Mg–Mn	Plate & sheet
SB-209	A95456	5456	38	25	...	105	...	Al–5.1Mg–Mn	Plate & sheet > 7–8 in., incl.
SB-209	A95456	5456	39	25	...	105	...	Al–5.1Mg–Mn	Plate & sheet > 5–7 in., incl.
SB-209	A95456	5456	40	25	...	105	...	Al–5.1Mg–Mn	Plate & sheet > 3–5 in., incl.
SB-209	A95456	5456	41	25	...	105	...	Al–5.1Mg–Mn	Plate & sheet > 1.5–3 in., incl.
SB-209	A95456	5456	42	25	...	105	...	Al–5.1Mg–Mn	Plate & sheet > 0.05–1.5 in., incl.
SB-209	A95652	5652	25	22	...	105	...	Al–2.5Mg	Plate & sheet
SB-209	A96061	6061	24	23	...	105	...	Al–Mg–Si–Cu	Plate & sheet
SB-209	...	Alclad 3003	13	21	...	104	...	Al–Mn–Cu	Plate & sheet > 0.05 < 0.5 in.
SB-209	...	Alclad 3003	14	21	...	104	...	Al–Mn–Cu	Plate & sheet ≥ 0.5–3 in., incl.
SB-209	...	Alclad 3004	21	22	...	104	...	Al–Mn–Mg	Plate & sheet > 0.05 < 0.5 in.
SB-209	...	Alclad 3004	22	22	...	104	...	Al–Mn–Mg	Plate & sheet ≥ 0.5–3 in., incl.
SB-209	...	Alclad 6061	24	23	...	105	...	Al–Mg–Si–Cu	Plate & sheet
B 209	A95050	5050	18	...	21	...	105	Al–1.5Mg	Plate & sheet
SB-210	A91060	1060	8.5	21	...	104	...	99.6Al	Smls. tube
SB-210	...	Alclad 3003	13	21	...	104	...	Al–Mn–Cu	Smls. tube
SB-210	A93003	3003	14	21	...	104	...	Al–Mn–Cu	Smls. tube
SB-210	A95052	5052	25	22	...	105	...	Al–2.5Mg	Smls. tube
SB-210	A95154	5154	30	22	...	105	...	Al–3.5Mg	Smls. tube
SB-210	A96061	6061	24	23	...	105	...	Al–Mg–Si–Cu	Smls. tube
SB-210	A96063	6063	17	23	...	105	...	Al–Mg–Si	Smls. tube
B 210	A95083	5083	39	...	25	...	105	Al–4.4Mg–Mn	Smls. tube
B 210	A95086	5086	35	...	25	...	105	Al–4.0Mg–Mn	Smls. tube
B 210	A95456	5456	41	...	25	...	...	Al–5.1Mg–Mn	Smls. tube
SB-211	A96061	6061	24	23	...	105	...	Al–Mg–Si–Cu	Bar, rod, & wire
SB-221	A91060	1060	8.5	21	...	104	...	99.6Al	Bar, rod, & shapes
SB-221	A91100	1100	11	21	...	104	...	99.0Al	Bar, rod, & shapes
SB-221	A93003	3003	14	21	...	104	...	Al–Mn–Cu	Bar, rod, & shapes
SB-221	A95083	5083	39	25	...	105	...	Al–4.4Mg–Mn	Bar, rod, & shapes
SB-221	A95154	5154	30	22	...	105	...	Al–3.5Mg	Bar, rod, & shapes

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-221	A95454	5454	31	22	...	105	...	Al–2.75Mg–Mn	Bar, rod, & shapes
SB-221	A95456	5456	41	25	...	105	...	Al–5.1Mg–Mn	Bar, rod, & shapes
SB-221	A96061	6061	24	23	...	105	...	Al–Mg–Si–Cu	Bar, rod, & shapes
SB-221	A96063	6063	17	23	...	105	...	Al–Mg–Si	Bar, rod, & shapes
SB-234	A91060	1060	8.5	21	...	104	...	99.6Al	Smls. tube
SB-234	...	Alclad 3003	13	21	...	104	...	Al–Mn–Cu	Smls. tube
SB-234	A93003	3003	14	21	...	104	...	Al–Mn–Cu	Smls. tube
SB-234	A95052	5052	25	22	...	105	...	Al–2.5Mg	Smls. tube
SB-234	A95454	5454	31	22	...	105	...	Al–2.75Mg–Mn	Smls. tube
SB-234	A96061	6061	24	23	...	105	...	Al–Mg–Si–Cu	Smls. tube
SB-241	A91060	1060	8.5	21	...	104	...	99.6Al	Smls. pipe & tube
SB-241	A91100	1100	11	21	...	104	...	99.0Al	Smls. pipe & tube
SB-241	...	Alclad 3003	13	21	...	104	...	Al–Mn–Cu	Smls. pipe & tube
SB-241	A93003	3003	14	21	...	104	...	Al–Mn–Cu	Pipe & tube
SB-241	A95052	5052	25	22	...	105	...	Al–2.5Mg	Smls. pipe & tube
SB-241	A95083	5083	39	25	...	105	...	Al–4.4Mg–Mn	Smls. pipe & tube
SB-241	A95086	5086	35	25	...	105	...	Al–4.0Mg–Mn	Smls. pipe & tube
SB-241	A95454	5454	31	22	...	105	...	Al–2.7Mg–Mn	Smls. pipe & tube
SB-241	A95456	5456	41	25	...	105	...	Al–5.1Mg–Mn	Smls. pipe & tube
SB-241	A96061	6061	24	23	...	105	...	Al–Mg–Si–Cu	Smls. pipe & tube
SB-241	A96063	6063	17	23	...	105	...	Al–Mg–Si	Smls. pipe & tube
SB-247	A93003	3003	14	21	...	104	...	Al–Mn–Cu	Forgings
SB-247	A95083	5083	38	25	...	105	...	Al–4.4Mg–Mn	Forgings
SB-247	A96061	6061	24	23	...	105	...	Al–Mg–Si–Cu	Forgings
SB-265	R50250	1	35	51	...	115	...	Ti	Plate, sheet, & strip
SB-265	R50400	2	50	51	...	115	...	Ti	Plate, sheet, & strip
SB-265	R50550	3	65	52	...	115	...	Ti	Plate, sheet, & strip
SB-265	R52400	7	50	51	...	115	...	Ti–Pd	Plate, sheet, & strip
SB-265	R53400	12	70	52	...	115	...	Ti–0.3Mo–0.8Ni	Plate, sheet, & strip
SB-265	R56320	9	90	53	...	115	...	Ti–3Al–2.5V	Plate, sheet, & strip
SB-265	R52402	16	50	51	...	115	...	Ti–Pd	Plate, sheet, & strip
SB-265	R52250	11	35	51	...	115	...	Ti–Pd	Plate, sheet, & strip
SB-265	R52252	17	35	51	...	...	...	Ti–Pd	Plate, sheet, & strip

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-271	C95200	...	65	35	...	108	...	88Cu–9Al–3Fe	Castings
SB-271	C95400	...	75	35	...	108	...	85Cu–11Al–4Fe	Castings
B 280	C10200	102	30	...	31	...	107	99.95Cu–P	Smls. tube
B 280	C12000	120	30	...	31	...	107	99.9Cu–P	Smls. tube
B 280	C12200	122	30	...	31	...	107	99.9Cu–P	Smls. tube
B 283	C11000	Cu	33	...	31	...	107	99.9Cu	Forgings
B 283	C37700	Forging brass	46	...	...	...	107	60Cu–38Zn–2Pb	Forgings > 1.5 in.
B 283	C37700	Forging brass	50	...	...	...	107	60Cu–38Zn–2Pb	Forgings ≤ 1.5 in.
B 283	C46400	Naval brass	64	...	32	...	107	60Cu–39Zn–Sn	Forgings
B 283	C65500	High Si bronze	52	...	33	...	107	97Cu–3Si	Forgings
B 283	C67500	Mn bronze	72	...	32	...	107	59Cu–39Zn–Fe–Sn	Forgings
B 302	C12000	...	36	...	31	...	107	99.9Cu–P	Pipe
B 302	C12200	...	36	...	31	...	107	99.9Cu–P	Pipe
SB-308	A96061	6061	24	23	...	105	...	Al–Mg–Si	Shapes
SB-315	C65500	...	50	33	...	107	...	97Cu–3Si	Pipe & tube
SB-333	N10001	...	100	44	...	112	...	62Ni–28Mo–5Fe	Plate, sheet, & strip ≥ 0.1875–2.5 in., incl.
SB-333	N10001	...	115	44	...	112	...	62Ni–28Mo–5Fe	Plate, sheet, & strip ≤ 0.1875 in.
SB-333	N10665	...	110	44	...	112	...	65Ni–28Mo–2Fe	Plate, sheet, & strip
SB-333	N10675	...	110	44	...	112	...	65Ni–29.5Mo–2Cr–2Fe–Mn–W	Plate, sheet, & strip
SB-335	N10001	...	100	44	...	112	...	62Ni–28Mo–5Fe	Rod > 1.5–3.5 in., incl.
SB-335	N10001	...	115	44	...	112	...	62Ni–28Mo–5Fe	Rod ≥ 0.3125–1.5 in., incl.
SB-335	N10665	...	110	44	...	112	...	65Ni–28Mo–2Fe	Rod
SB-335	N10675	...	110	44	...	112	...	65Ni–29.5Mo–2Cr–2Fe–Mn–W	Rod
SB-337	R50250	1	35	51	...	115	...	Ti	Smls. & welded pipe
SB-337	R50400	2	50	51	...	115	...	Ti	Smls. & welded pipe
SB-337	R50550	3	65	52	...	115	...	Ti	Smls. & welded pipe
SB-337	R52400	7	50	51	...	115	...	Ti–Pd	Smls. & welded pipe
SB-337	R53400	12	70	52	...	115	...	Ti–0.3Mo–0.8Ni	Smls. & welded pipe
SB-337	R56320	9	90	53	...	115	...	Ti–3Al–2.5V	Smls. & welded pipe
SB-338	R50250	1	35	51	...	115	...	Ti	Smls. & welded tube
SB-338	R50400	2	50	51	...	115	...	Ti	Smls. & welded tube

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-338	R50550	3	65	52	...	115	...	Ti	Smls. & welded tube
SB-338	R52400	7	50	51	...	115	...	Ti–Pd	Smls. & welded tube
SB-338	R52402	16	50	51	...	115	...	Ti–Pd	Smls. & welded tube
SB-338	R53400	12	70	52	...	115	...	Ti–0.3Mo–0.8Ni	Smls. & welded tube
SB-338	R56320	9	90	53	...	115	...	Ti–3Al–2.5V	Smls. & welded tube
B 345	A91060	1060	8.5	...	21	...	104	99.6Al	Smls. pipe & tube
B 345	A93003	3003	...	...	21	...	104	Al–Mn–Cu	Smls. pipe & tube
B 345	A95083	5083	39	...	25	...	105	Al–4.4Mg–Mn	Smls. pipe & tube
B 345	A95086	5086	37	...	25	...	105	Al–4.0Mg–Mn	Smls. pipe & tube
B 345	A96061	6061	24	...	23	...	105	Al–Mg–Si–Cu	Smls. pipe & tube
B 345	A96063	6063	17	...	23	...	105	Al–Mg–Si	Smls. pipe & tube
SB-348	R50250	1	35	51	...	115	...	Ti	Bars & billets
SB-348	R50400	2	50	51	...	115	...	Ti	Bars & billets
SB-348	R50550	3	65	52	...	115	...	Ti	Bars & billets
SB-348	R52400	7	50	51	...	115	...	Ti–Pd	Bars & billets
SB-348	R53400	12	70	52	...	115	...	Ti–0.3Mo–0.8Ni	Bars & billets
SB-348	R52402	16	50	51	...	...	...	Ti–Pd	Bars & billets
SB-348	R56320	9	90	53	...	115	...	Ti–3Al–2.5V	Bars & billets
A 351	N08030	HT30	65	...	45	...	111	13Cr–35Ni–5Mo	Castings
SA-351	J94651	CN3MN	80	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Castings
SA-351	N08007	CN7M	62	45	...	111	...	28Ni–19Cr–Cu–Mo	Castings
SA-351	N08151	CT15C	63	45	...	111	...	32Ni–45Fe–20Cr–Cb	Castings
SB-359	C10200	...	30	31	...	107	...	99.95Cu–P	Smls. tube
SB-359	C12000	...	30	31	...	107	...	99.9Cu–P	Smls. tube
SB-359	C12200	...	30	31	...	107	...	99.9Cu–P	Smls. tube
SB-359	C14200	...	30	31	...	107	...	99.4Cu–As-P	Smls. tube
SB-359	C19200	...	38	31	...	107	...	99.7Cu–Fe–P	Smls. tube
SB-359	C23000	...	40	32	...	107	...	85Cu–15Zn	Smls. tube
SB-359	C44300	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06As	Smls. tube
SB-359	C44400	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06Sb	Smls. tube
SB-359	C44500	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06P	Smls. tube
SB-359	C60800	...	50	35	...	108	...	95Cu–5Al	Smls. tube
SB-359	C68700	...	50	32	...	108	...	78Cu–20Zn–2Al	Smls. tube

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-359	C70400	...	38	34	...	107	...	95Cu–5Ni	Smls. tube
SB-359	C70600	...	40	34	...	107	...	90Cu–10Ni	Smls. tube
SB-359	C71000	...	45	34	...	107	...	80Cu–20Ni	Smls. tube
SB-359	C71500	...	52	34	...	107	...	70Cu–30Ni	Smls. tube
B 361	A91060	WP1060	8	...	21	...	104	99.5Al	Fittings
B 361	A91100	WP1100	11	...	21	...	104	99.0Al	Fittings
B 361	...	WP Alclad 3003	13	...	21	...	104	Al–Mn–Cu	Fittings
B 361	A93003	WP3003	14	...	21	...	104	Al–Mn–Cu	Fittings
B 361	A95083	5083	39	...	25	...	105	Al–4.4Mg–Mn	Fittings
B 361	A95154	5154	30	...	22	...	105	Al–3.5Mg	Fittings
B 361	A96061	WP6061	24	...	23	...	105	Al–Mg–Si–Cu	Fittings
B 361	A96063	WP6063	17	...	23	...	105	Al–Mg–Si	Fittings
SB-363	R50250	WPT 1	35	51	...	115	...	Ti	Smls. & welded fittings
SB-363	R50400	WPT 2	50	51	...	115	...	Ti	Smls. & welded fittings
SB-363	R50550	WPT 3	65	52	...	115	...	Ti	Smls. & welded fittings
SB-363	R52400	7	50	51	...	115	...	Ti–Pd	Smls. & welded pipe
SB-363	R53400	12	70	52	...	115	...	Ti–0.3Mo–0.8Ni	Smls. & welded pipe
SB-363	R56320	WPT-9	90	53	...	115	...	Ti–3Al–2.5V	Smls. & welded fittings
SB-366	N02200	...	55	41	...	110	...	99Ni	Fittings
SB-366	N02201	...	50	41	...	110	...	99Ni-Low C	Fittings
SB-366	N04400	...	70	42	...	110	...	67Ni–30Cu	Fittings
SB-366	N06002	...	100	43	...	111	...	47Ni–22Cr–18Fe–9Mo	Fittings
SB-366	N06007	...	90	45	...	111	...	47Ni–22Cr–19Fe–6Mo	Fittings
SB-366	N06022	...	100	44	...	112	...	55Ni–21Cr–13.5Mo	Fittings
SB-366	N06030	...	85	45	...	111	...	40Ni–29Cr–15Fe–5Mo	Fittings
SB-366	N06059	...	100	44	...	112	...	59Ni–23Cr–16Mo	Fittings
SB-366	N06230	...	110	47	...	...	...	53Ni–22Cr–14W–Co–Fe–Mo	Fittings
SB-366	N06455	...	100	44	...	112	...	61Ni–15Mo–16Cr	Fittings
SB-366	N06600	...	80	43	...	111	...	72Ni–15Cr–8Fe	Fittings
SB-366	N06625	...	110	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Fittings
SB-366	N06985	...	90	45	...	111	...	47Ni–22Cr–20Fe–7Mo	Fittings
SB-366	N08020	...	80	45	...	111	...	35Ni–35Fe–20Cr–Cb	Fittings
SB-366	N08330	...	70	46	...	111	...	35Ni–19Cr–1.25Si	Fittings
SB-366	N08800	...	75	45	...	111	...	33Ni–42Fe–21Cr	Fittings

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-366	N08825	...	85	45	...	111	...	42Ni–21.5Cr–3Mo–2.3Cu	Fittings
SB-366	N08925	...	87	45	...	111	...	25Ni–20Cr–6Mo–Cu–N	Fittings
SB-366	N10001	...	100	44	...	112	...	62Ni–28Mo–5Fe	Fittings
SB-366	N10003	...	100	44	...	112	...	70Ni–16Mo–7Cr–5Fe	Fittings
SB-366	N10276	...	100	44	...	112	...	54Ni–16Mo–15Cr	Fittings
SB-366	N10665	...	110	44	...	112	...	65Ni–28Mo–2Fe	Fittings
SB-366	N10675	...	110	44	...	112	...	65Ni–29.5Mo–2Cr–2Fe–Mn–W	Fittings
B 366	N08031	...	94	...	45	...	111	31Ni–36Fe–27Cr–6Mo	Fittings
B 366	N08926	...	94	...	45	...	111	25Ni–20Cr–6Mo–Cu–N	Fittings
SB-367	R50400	Gr. C–2	50	51	...	115	...	Ti	Castings
SB-367	R50550	Gr. C–3	65	52	...	115	...	Ti	Castings
SB-369	C96200	...	45	34	...	107	...	87.5Cu–10Ni–1.4Fe–0.75Nb	Castings
SB-381	R50250	F–1	35	51	...	115	...	Ti	Forgings
SB-381	R50400	F–2	50	51	...	115	...	Ti	Forgings
SB-381	R50550	F–3	65	52	...	115	...	Ti	Forgings
SB-381	R52400	F–7	50	51	...	115	...	Ti–Pd	Forgings
SB-381	R52402	F–16	50	51	...	...	...	Ti–Pd	Forgings
SB-381	R53400	F–12	70	52	...	115	...	Ti–0.3Mo–0.8Ni	Forgings
SB-381	R56320	F–9	90	53	...	115	...	Ti–3Al–2.5V	Forgings
SB-395	C10200	...	36	31	...	107	...	99.95Cu–P	Smls. tube
SB-395	C12000	...	36	31	...	107	...	99.9Cu–P	Smls. tube
SB-395	C12200	...	36	31	...	107	...	99.9Cu–P	Smls. tube
SB-395	C14200	...	36	31	...	107	...	99.4Cu–As–P	Smls. tube
SB-395	C19200	...	38	31	...	107	...	99.7Cu–Fe–P	Smls. tube
SB-395	C23000	...	40	32	...	107	...	85Cu–15Zn	Smls. tube
SB-395	C44300	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06As	Smls. tube
SB-395	C44400	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06Sb	Smls. tube
SB-395	C44500	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06P	Smls. tube
SB-395	C60800	...	50	35	...	108	...	95Cu–5Al	Smls. tube
SB-395	C68700	...	50	32	...	108	...	78Cu–20Zn–2Al	Smls. tube
SB-395	C70600	...	40	34	...	107	...	90Cu–10Ni	Smls. tube

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-395	C71000	...	45	34	...	107	...	80Cu–20Ni	Smls. tube
SB-395	C71500	...	52	34	...	107	...	70Cu–30Ni	Smls. tube
SB-407	N08800	...	75	45	...	111	...	33Ni–42Fe–21Cr	Smls. pipe & tube
SB-407	N08810	...	65	45	...	111	...	33Ni–42Fe–21Cr	Smls. pipe & tube
SB-407	N08811	...	65	45	...	111	...	33Ni–42Fe–21Cr–1 (Al + Ti)	Smls. pipe & tube
SB-408	N08800	...	75	45	...	111	...	33Ni–42Fe–21Cr	Rod & bar
SB-408	N08810	...	65	45	...	111	...	33Ni–42Fe–21Cr	Rod & bar
SB-408	N08811	...	65	45	...	111	...	33Ni–42Fe–21Cr–1 (Al + Ti)	Rod & bar
SB-409	N08800	...	75	45	...	111	...	33Ni–42Fe–21Cr	Plate, sheet, & strip
SB-409	N08810	...	65	45	...	111	...	33Ni–42Fe–21Cr	Plate, sheet, & strip
SB-409	N08811	...	65	45	...	111	...	33Ni–42Fe–21Cr–1 (Al + Ti)	Plate, sheet, & strip
SB-423	N08825	...	75	45	...	111	...	42Ni–21.5Cr–3Mo–2.3Cu	Smls. pipe & tube
SB-424	N08825	...	85	45	...	111	...	42Ni–21.5Cr–3Mo–2.3Cu	Plate, sheet, & strip
SB-425	N08825	...	85	45	...	111	...	42Ni–21.5Cr–3Mo–2.3Cu	Rod & bar
SB-434	N10003	...	100	44	...	112	...	70Ni–16Mo–7Cr–5Fe	Plate, sheet, & strip
SB-435	N06002	...	95	43	...	111	...	47Ni–22Cr–9Mo–18Fe	Plate, sheet, & strip
SB-435	N06002	...	100	43	...	111	...	47Ni–22Cr–9Mo–18Fe	Plate, sheet, & strip, $\frac{1}{16}$ in. $< t < \frac{3}{16}$ in.
SB-435	N06230	...	110	47	...	111	...	53Ni–22Cr–14W–Co–Fe–Mo	Plate, sheet, & strip
SB-435	R30556	...	100	45	...	111	...	21Ni–30Fe–22Cr–18Co–3Mo–3W	Plate, sheet, & strip
SB-443	N06625	2	100	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Plate, sheet, & strip
SB-443	N06625	1	110	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Plate, sheet, & strip
SB-444	N06625	1	120	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Pipe & tube
SB-444	N06625	2	100	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Pipe & tube
SB-446	N06625	1	120	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Rod & bar
SB-446	N06625	2	100	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Rod & bar
SB-462	N08020	...	80	45	...	111	...	35Ni–35Fe–20Cr–Cb	Forgings
SB-462	N08367	...	95	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Forgings

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-463	N08020	...	80	45	...	111	...	35Ni–35Fe–20Cr–Cb	Plate, sheet, & strip
SB-463	N08024	...	80	45	...	111	...	37Ni–33Fe–23Cr–4Mo–1Cu	Plate, sheet, & strip
SB-463	N08026	...	80	45	...	111	...	35Ni–30Fe–24Cr–5Mo–Cu	Plate, sheet, & strip
SB-464	N08020	...	80	45	...	111	...	35Ni–35Fe–20Cr–Cb	Welded pipe
SB-464	N08024	...	80	45	...	111	...	37Ni–33Fe–23Cr–4Mo–1Cu	Welded pipe
SB-464	N08026	...	80	45	...	111	...	35Ni–30Fe–24Cr–5Mo–Cu	Welded pipe
SB-466	C70600	...	38	34	...	107	...	90Cu–10Ni	Pipe & tube
SB-466	C71000	...	45	34	...	107	...	80Cu–20Ni	Pipe & tube
SB-466	C71500	...	50	34	...	107	...	70Cu–30Ni	Pipe & tube
SB-467	C70600	...	38	34	...	107	...	90Cu–10Ni	Pipe > 4.5 in. O.D.
SB-467	C70600	...	40	34	...	107	...	90Cu–10Ni	Pipe ≤ 4.5 in. O.D.
SB-467	C71500	...	45	34	...	107	...	70Cu–30Ni	Pipe > 4.5 in. O.D.
SB-467	C71500	...	50	34	...	107	...	70Cu–30Ni	Pipe ≤ 4.5 in. O.D.
SB-468	N08020	...	80	45	...	111	...	35Ni–35Fe–20Cr–Cb	Welded tube
SB-468	N08024	...	80	45	...	111	...	37Ni–33Fe–23Cr–4Mo–1Cu	Welded tube
SB-468	N08026	...	80	45	...	111	...	35Ni–30Fe–24Cr–5Mo–2Cu	Welded tube
SB-473	N08020	...	80	45	...	111	...	35Ni–35Fe–20Cr–Cb	Bar
B 491	A93003	3003	14	...	21	...	104	Al–Mn–Cu	Extruded tubes
SB-493	R60702	R60702	55	61	...	117	...	99.2Zr	Forgings
SB-493	R60705	R60705	70	62	...	117	...	99.5Zr–2.5Nb	Forgings
SA-494	N26022	CX2MW	80	44	...	...	...	59Ni–22Cr–14Mo–4Fe–3W	Castings
SB-505	C95200	...	68	35	...	108	...	88Cu–9Al–3Fe	Castings
SB-511	N08330	...	70	46	...	111	...	35Ni–19Cr–1.25Si	Bars & shapes
SB-514	N08800	...	75	45	...	111	...	33Ni–42Fe–21Cr	Welded pipe
SB-514	N08810	...	65	45	...	111	...	33Ni–42Fe–21Cr	Welded pipe
SB-515	N08800	...	75	45	...	111	...	33Ni–21Cr	Welded tube
SB-515	N08810	...	65	45	...	111	...	33Ni–21Cr	Welded tube
SB-515	N08811	...	65	45	...	...	...	33Ni–42Fe–21Cr–1 (Al + Ti)	Welded tube

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-516	N06600	...	80	43	...	111	...	72Ni–15Cr–8Fe	Welded tube
SB-517	N06600	...	80	43	...	111	...	72Ni–15Cr–8Fe	Welded pipe
SB-523	R60702	R60702	55	61	...	117	...	99.2Zr	Smls. & welded tube
SB-523	R60705	R60705	80	62	...	117	...	99.5Zr–2.5Nb	Smls. & welded tube
SB-535	N08330	...	70	46	...	111	...	35Ni–19Cr–1.25Si	Smls. pipe
SB-536	N08330	...	70	46	...	111	...	35Ni–19Cr–1.25Si	Plate, sheet, & strip
SB-543	C12200	...	30	31	...	107	...	99.9Cu–P	Welded tube
SB-543	C19400	...	45	31	...	107	...	97.5Cu–P	Welded tube
SB-543	C23000	...	40	32	...	107	...	85Cu–15Zn	Welded tube
SB-543	C44300	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06As	Welded tube
SB-543	C44400	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06Sb	Welded tube
SB-543	C44500	...	45	32	...	107	...	71Cu–28Zn–1Sn–0.06P	Welded tube
SB-543	C68700	...	50	32	...	108	...	78Cu–20Zn–2Al	Welded tube
SB-543	C70400	...	38	34	...	107	...	95Cu–5Ni	Welded tube
SB-543	C70600	...	40	34	...	107	...	90Cu–10Ni	Welded tube
SB-543	C71500	...	52	34	...	107	...	70Cu–30Ni	Welded tube
SB-543	C71640	...	63	34	...	107	...	66Cu–30.5Ni–2Fe–2Mn	Welded tube
B 547	...	Alclad 3003	13	...	21	...	104	Al–Mn–Cu	Welded tube
B 547	A93003	3003	14	...	21	...	104	Al–Mn–Cu	Welded tube
B 547	A95083	5083	40	...	25	...	105	Al–4.4Mg–Mn	Welded tube
B 547	A95454	5454	31	...	22	...	105	Al–2.7Mg–Mn	Welded tube
B 547	A96061	6061	24	...	23	...	105	Al–Mg–Si–Cu	Welded tube
SB-550	R60702	R60702	55	61	...	117	...	99.2Zr	Bar & wire
SB-550	R60705	R60705	80	62	...	117	...	95.2Zr+Nb	Bar & wire
SB-551	R60702	R60702	55	61	...	117	...	99.2Zr	Plate, sheet, & strip
SB-551	R60705	R60705	80	62	...	117	...	99.5Zr–2.5Nb	Plate, sheet, & strip
SB-564	N04400	...	70	42	...	110	...	67Ni–30Cu	Forgings
SB-564	N06022	...	100	44	...	112	...	55Ni–21Cr–13.5Mo	Forgings
SB-564	N06059	...	100	44	...	111	...	59Ni–23Cr–16Mo	Forgings

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-564	N06230	...	110	47	...	...	...	53Ni–22Cr–14W–Co–Fe–Mo	Forgings
SB-564	N06600	...	80	43	...	111	...	72Ni–15Cr–8Fe	Forgings
SB-564	N06625	...	110	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Forgings > 4–10 in., incl.
SB-564	N06625	...	120	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Forgings ≤ 4 in.
SB-564	N06690	...	85	43	...	...	...	58Ni–29Cr–9Fe	Forgings
SB-564	N08800	...	75	45	...	111	...	33Ni–42Fe–21Cr	Forgings
SB-564	N08810	...	65	45	...	111	...	33Ni–42Fe–21Cr	Forgings
SB-564	N08811	...	65	45	...	...	...	33Ni–21Cr–1 (Al + Ti)	Forgings
SB-564	N08367	...	95	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Forgings
SB-564	N10276	...	100	44	...	112	...	54Ni–16Mo–15Cr	Forgings
SB-564	N10675	...	110	44	...	112	...	65Ni–29.5Mo–2Cr–2Fe–Mn–W	Forgings
B 564	N02200	...	55	...	41	...	110	99.0Ni	Forgings
B 564	N08031	...	94	...	45	...	111	31Ni–38Fe–27Cr–5.5Mo	Forgings
B 564	N08811	...	65	...	45	...	111	33Ni–42Fe–21Cr–1(Al+Ti)	Forgings
SB-572	N06002	...	95	43	...	111	...	47Ni–22Cr–9Mo–18Fe	Rod
SB-572	N06230	...	110	47	...	111	...	53Ni–22Cr–14W–Co–Fe–Mo	Rod
SB-572	R30556	...	100	45	...	111	...	21Ni–30Fe–22Cr–18Co–3Mo–3W	Rod
SB-573	N10003	...	100	44	...	112	...	70Ni–16Mo–7Cr–5Fe	Rod
SB-574	N06022	...	100	44	...	112	...	55Ni–21Cr–13.5Mo	Rod
SB-574	N06059	...	100	44	...	112	...	59Ni–23Cr–16Mo	Rod
SB-574	N06455	...	100	44	...	112	...	61Ni–16Mo–16Cr	Rod
SB-574	N10276	...	100	44	...	112	...	54Ni–16Mo–15Cr	Rod
SB-575	N06022	...	100	44	...	112	...	55Ni–21Cr–13.5Mo	Plate, sheet, & strip
SB-575	N06059	...	100	44	...	112	...	59Ni–23Cr–16Mo	Plate, sheet, & strip
SB-575	N06455	...	100	44	...	112	...	61Ni–16Mo–16Cr	Plate, sheet, & strip
SB-575	N10276	...	100	44	...	112	...	54Ni–16Mo–15Cr	Plate, sheet, & strip
SB-581	N06007	...	85	45	...	111	...	47Ni–22Cr–19Fe–6Mo	Rod > 0.75–3.5 in., incl.
SB-581	N06007	...	90	45	...	111	...	47Ni–22Cr–19Fe–6Mo	Rod, 0.3125–0.75 in., incl.
SB-581	N06030	...	85	45	...	111	...	40Ni–29Cr–15Fe–5Mo	Rod
SB-581	N06975	...	85	45	...	111	...	49Ni–25Cr–18Fe–6Mo	Rod
SB-581	N06985	...	85	45	...	111	...	47Ni–22Cr–20Fe–7Mo	Rod > 0.75–3.5 in., incl.
SB-581	N06985	...	90	45	...	111	...	47Ni–22Cr–20Fe–7Mo	Rod, 0.3125–0.75 in., incl.

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-582	N06007	...	85	45	...	111	...	47Ni–22Cr–19Fe–6Mo	Plate, sheet, & strip > 0.75–2.5 in., incl.
SB-582	N06007	...	90	45	...	111	...	47Ni–22Cr–19Fe–6Mo	Plate, sheet, & strip ≤ 0.75 in.
SB-582	N06030	...	85	45	...	111	...	40Ni–29Cr–15Fe–5Mo	Plate, sheet, & strip
SB-582	N06975	...	85	45	...	111	...	49Ni–25Cr–18Fe–6Mo	Plate, sheet, & strip
SB-582	N06985	...	85	45	...	111	...	47Ni–22Cr–20Fe–7Mo	Plate, sheet, & strip > 0.75–2.5 in., incl.
SB-582	N06985	...	90	45	...	111	...	47Ni–22Cr–20Fe–7Mo	Plate, sheet, & strip ≤ 0.75 in.
SB-599	N08700	...	80	45	...	111	...	25Ni–47Fe–21Cr–5Mo	Plate, sheet, & strip
SB-619	N06002	...	100	43	...	111	...	47Ni–22Cr–9Mo–18Fe	Welded pipe
SB-619	N06007	...	90	45	...	111	...	47Ni–22Cr–19Fe–6Mo	Welded pipe
SB-619	N06022	...	100	44	...	112	...	55Ni–21Cr–13.5Mo	Welded pipe
SB-619	N06030	...	85	45	...	111	...	40Ni–29Cr–15Fe–5Mo	Welded pipe
SB-619	N06059	...	100	44	...	112	...	59Ni–23Cr–16Mo	Welded pipe
SB-619	N06230	...	110	47	...	111	...	53Ni–22Cr–14W–Co–Fe–Mo	Welded pipe
SB-619	N06455	...	100	44	...	112	...	61Ni–16Mo–16Cr	Welded pipe
SB-619	N06975	...	85	45	...	111	...	49Ni–25Cr–18Fe–6Mo	Welded pipe
SB-619	N06985	...	90	45	...	111	...	47Ni–22Cr–20Fe–7Mo	Welded pipe
SB-619	N08320	...	75	45	...	111	...	26Ni–22Cr–5Mo–Ti	Welded pipe
SB-619	N10001	...	100	44	...	112	...	62Ni–28Mo–5Fe	Welded pipe
SB-619	N10276	...	100	44	...	112	...	54Ni–16Mo–15Cr	Welded pipe
SB-619	N10665	...	110	44	...	112	...	65Ni–28Mo–2Fe	Welded pipe
SB-619	N10675	...	110	44	...	112	...	65Ni–29.5Mo–2Cr–2Fe–Mn–W	Welded pipe
SB-619	R30556	...	100	45	...	111	...	21Ni–30Fe–22Cr–18Co–3Mo–3W	Welded pipe
B 619	N06059	...	100	...	44	...	112	59Ni–23Cr–16Mo	Welded pipe
B 619	N08031	...	94	...	45	...	111	31Ni–36Fe–27Cr–6Mo	Welded pipe
SB-620	N08320	...	75	45	...	111	...	26Ni–22Cr–5Mo–Ti	Plate, sheet, & strip
SB-621	N08320	...	75	45	...	111	...	26Ni–22Cr–5Mo–Ti	Rod
SB-622	N06002	...	100	43	...	111	...	47Ni–22Cr–9Mo–18Fe	Smls. pipe & tube
SB-622	N06007	...	90	45	...	111	...	47Ni–22Cr–19Fe–6Mo	Smls. pipe & tube
SB-622	N06022	...	100	44	...	112	...	55Ni–21Cr–13.5Mo	Smls. pipe & tube
SB-622	N06030	...	85	45	...	111	...	40Ni–29Cr–15Fe–5Mo	Smls. pipe & tube
SB-622	N06059	...	100	44	...	112	...	59Ni–23Cr–16Mo	Smls. pipe & tube

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-622	N06230	...	110	47	...	111	...	53Ni–22Cr–14W–Co–Fe–Mo	Smls. pipe & tube
SB-622	N06455	...	100	44	...	112	...	61Ni–16Mo–16Cr	Smls. pipe & tube
SB-622	N06975	...	85	45	...	111	...	49Ni–25Cr–18Fe–6Mo	Smls. pipe & tube
SB-622	N06985	...	90	45	...	111	...	47Ni–22Cr–20Fe–7Mo	Smls. pipe & tube
SB-622	N08320	...	75	45	...	111	...	26Ni–22Cr–5Mo–Ti	Smls. pipe & tube
SB-622	N10001	...	100	44	...	112	...	62Ni–28Mo–5Fe	Smls. pipe & tube
SB-622	N10276	...	100	44	...	112	...	54Ni–16Mo–15Cr	Smls. pipe & tube
SB-622	N10665	...	110	44	...	112	...	65Ni–28Mo–2Fe	Smls. pipe & tube
SB-622	R30556	...	100	45	...	111	...	21Ni–30Fe–22Cr–18Co–3Mo–3W	Smls. pipe & tube
SB-622	N10675	...	110	44	...	112	...	65Ni–29.5Mo–2Cr–2Fe–Mo–W	Smls. pipe & tube
B 622	N06059	...	100	...	44	...	112	59Ni–23Cr–16Mo	Smls. pipe & tube
B 622	N08031	...	94	...	45	...	111	31Ni–36Fe–27Cr–6Mo	Smls. pipe & tube
B 625	N08926	...	87	...	45	...	111	25Ni–20Cr–6Mo–Co–N	Plate, sheet, & strip
SB-625	N08904	...	71	45	...	111	...	44Fe–25Ni–21Cr–Mo	Plate, sheet, & strip
SB-625	N08925	...	87	45	...	111	...	25Ni–20Cr–6Mo–Cu–N	Plate, sheet, & strip
SB-626	N06002	...	100	43	...	111	...	47Ni–22Cr–9Mo–18Fe	Welded tube
SB-626	N06007	...	90	45	...	111	...	47Ni–22Cr–19Fe–6Mo	Welded tube
SB-626	N06022	...	100	44	...	112	...	55Ni–21Cr–13.5Mo	Welded tube
SB-626	N06030	...	85	45	...	111	...	40Ni–29Cr–15Fe–5Mo	Welded tube
SB-626	N06059	...	100	44	...	112	...	59Ni–23Cr–16Mo	Welded tube
SB-626	N06230	...	110	47	...	111	...	53Ni–22Cr–14W–Co–Fe–Mo	Welded tube
SB-626	N06455	...	100	44	...	112	...	61Ni–16Mo–16Cr	Welded tube
SB-626	N06975	...	85	45	...	111	...	49Ni–25Cr–18Fe–6Mo	Welded tube
SB-626	N06985	...	90	45	...	111	...	47Ni–22Cr–20Fe–7Mo	Welded tube
SB-626	N08320	...	75	45	...	111	...	26Ni–22Cr–5Mo–Ti	Welded tube
SB-626	N10001	...	100	44	...	112	...	62Ni–28Mo–5Fe	Welded tube
SB-626	N10276	...	100	44	...	112	...	54Ni–16Mo–15Cr	Welded tube
SB-626	N10665	...	110	44	...	112	...	65Ni–28Mo–2Fe	Welded tube
SB-626	R30556	...	100	45	...	111	...	21Ni–30Fe–22Cr–18Co–3Mo–3W	Welded tube
SB-626	N10675	...	110	44	...	112	...	65Ni–29.5Mo–2Cr–2Fe–Mn–W	Welded tube
B 649	N08926	...	87	...	45	...	111	25Ni–20Cr–6Mo–Cu–N	Bar & wire

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-649	N08904	...	71	45	...	111	...	44Fe–25Ni–21Cr–Mo	Bar & wire
SB-649	N08925	...	87	45	...	111	...	25Ni–20Cr–6Mo–Cu–N	Bar & wire
SB-658	R60702	R60702	55	61	...	117	...	99.2Zr	Smls. & welded pipe
SB-658	R60705	R60705	80	62	...	117	...	95.5Zr–2.5Nb	Smls. & welded pipe
SB-668	N08028	...	73	45	...	111	...	31Ni–31Fe–29Cr–Mo	Smls. tube
SB-672	N08700	...	80	45	...	111	...	25Ni–47Fe–21Cr–5Mo	Bar & wire
B 673	N08926	...	87	...	45	...	111	25Ni–20Cr–6Mo–Cu–N	Welded pipe
SB-673	N08904	...	71	45	...	111	...	44Fe–25Ni–21Cr–Mo	Welded pipe
SB-673	N08925	...	87	45	...	111	...	25Ni–20Cr–6Mo–Cu–N	Welded pipe
SB-674	N08904	...	71	45	...	111	...	44Fe–25Ni–21Cr–Mo	Welded tube
SB-674	N08925	...	87	45	...	111	...	25Ni–20Cr–6Mo–Cu–N	Welded tube
B 674	N08926	...	87	...	45	...	111	25Ni–20Cr–6Mo–Cu–N	Welded tube
SB-675	N08366	...	75	45	...	111	...	46Fe–24Ni–21Cr–6Mo	Welded pipe
SB-675	N08367	...	95	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Welded pipe
SB-676	N08366	...	75	45	...	111	...	46Fe–24Ni–21Cr–6Mo	Welded tube
SB-676	N08367	...	104	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Welded tube
B 677	N08926	...	87	...	45	...	111	25Ni–20Cr–6Mo–Cu–N	Smls. pipe & tube
SB-677	N08904	...	71	45	...	111	...	44Fe–25Ni–21Cr–Mo	Smls. pipe & tube
SB-677	N08925	...	87	45	...	111	...	25Ni–20Cr–6Mo–Cu–N	Smls. pipe & tube
SB-688	N08366	...	75	45	...	111	...	46Fe–24Ni–21Cr–6Mo	Plate, sheet, & strip
SB-688	N08367	...	104	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Plate, sheet, & strip $>^{3}/_{16}$ in.
SB-688	N08367	...	100	45	...	...	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Plate, sheet, & strip $\geq^{3}/_{16}$ $\leq^{3}/_{4}$ in.
SB-688	N08367	...	95	45	...	...	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Plate, sheet, & strip $>^{3}/_{4}$ in.
SB-690	N08366	...	75	45	...	111	...	46Fe–24Ni–21Cr–6Mo	Smls. pipe & tube
SB-690	N08367	...	95	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Smls. pipe & tube
SB-691	N08366	...	75	45	...	111	...	46Fe–24Ni–21Cr–6Mo	Rod, bar, & wire

QW/QB-422 NONFERROUS P-NUMBERS AND S-NUMBERS (CONT'D)
(Grouping of Base Metals for Qualification)

Spec. No.	UNS No.	Alloy, Type, or Grade	Minimum Specified Tensile, ksi	Welding		Brazing		Nominal Composition	Product Form
				P-No.	S-No.	P-No.	S-No.		
SB-691	N08367	...	95	45	...	111	...	46Fe–24Ni–21Cr–6Mo–Cu–N	Rod, bar, & wire
SB-704	N06625	...	120	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Welded tube
SB-704	N08825	...	85	45	...	111	...	42Ni–21.5Cr–3Mo–2.3Cu	Welded tube
SB-705	N06625	...	120	43	...	111	...	60Ni–22Cr–9Mo–3.5Cb	Welded pipe
SB-705	N08825	...	85	45	...	111	...	42Ni–21.5Cr–3Mo–2.3Cu	Welded pipe
SB-709	N08028	...	73	45	...	111	...	31Ni–31Fe–29Cr–Mo	Plate, sheet, & strip
SB-710	N08330	...	70	46	...	111	...	35Ni–19Cr–1.25Si	Welded pipe
SB-729	N08020	...	80	45	...	...	111	35Ni–35Fe–20Cr–Cb	Smls. pipe & tube
B 725	N02200	...	55	...	41	...	110	99.0Ni	Welded pipe
B 819	C12200	C12200	30	...	...	...	107	99.9Cu–P	Wrought pipe
B 16.18	C83600	...	40	...	...	...	107	5Sn–5Zn–5Pb	Cast fittings
B 16.18	C83800	...	40	...	...	...	107	4Sn–6.5Zn–6Pb	Cast fittings
B 16.18	C84400	...	40	...	...	...	107	2.5Sn–8.5Zn–7Pb	Cast fittings
B 16.22	C10200	...	30	...	...	...	107	99.95Cu–P	Wrought pipe fittings
B 16.22	C12000	...	30	...	...	...	107	99.9Cu–P	Wrought pipe fittings
B 16.22	C12200	...	30	...	...	...	107	99.9Cu–P	Wrought pipe fittings
B 16.22	C23000	...	30	...	...	...	107	85Cu–15Zn	Wrought pipe fittings

QW-423 Alternate Base Materials for Welder Qualification

A99 **QW-423.1** Base material used for welder qualification may be substituted for the P-Number material specified in the WPS in accordance with the following.

Base Metal(s) for Welder Qualification	Qualified Production Base Metal(s)
P-No. 1 through P-No. 11, P-No. 34, or P-No. 41 through P-No. 47	P-No. 1 through P-No. 11, P-No. 34, P-No. 41 through P-No. 47 and unassigned metals of similar chemical composition to these metals
P-No. 21 through P-No. 25	P-No. 21 through P-No. 25
P-No. 51 through P-No. 53 or P-No. 61 through P-No. 62	P-No. 51 through P-No. 53 and P-No. 61 through P-No. 62

98 **QW-423.2** Metals used for welder qualification conforming to national or international standards or specifications may be considered as having the same P- or S-Number as an assigned metal provided it meets the mechanical and chemical requirements of the assigned metal. The base metal specification and corresponding P- or S-Number shall be recorded on the qualification record.

QW-424 Base Metals Used for Procedure Qualification

QW-424.1 Base metals are assigned P-Numbers in QW/QB-422; metals which do not appear in QW/QB-422 are considered to be unassigned metals except as otherwise defined in QW-420.1 for base metals having the same UNS numbers. Unassigned metals shall be identified in the WPS and on the PQR by specification, type and grade, or by chemical analysis and mechanical properties. The minimum tensile strength shall be defined by the organization which specified the unassigned metal if the tensile strength of that metal is not defined by the material specification.

Base Metal(s) Used for Procedure Qualification Coupon	Base Metals Qualified
One metal from a P-Number to any metal from the same P-Number	Any metals assigned that P-Number
One metal from a P-Number to any metal from any other P-Number	Any metal assigned the first P-Number to any metal assigned the second P-Number
One metal from P-No. 3 to any metal from P-No. 3	Any P-No.3 metal to any metal from P-No. 3 or P-No. 1
One metal from P-No. 4 to any metal from P-No. 4	Any P-No. 4 metal to any metal from P-Nos. 4, 3, or 1
One metal from P-No. 5A to any metal from P-No. 5A	Any P-No. 5A metal to any metal from P-Nos. 5A, 4, 3, or 1 metals
One metal from P-No. 5A to a metal from P-No. 4, or P-No. 3, or P-No. 1	Any P-No. 5A metal to any metal assigned to P-No. 4, or P-No. 3, or P-No. 1
One metal from P-No. 4 to a metal from P-No. 3 or P-No. 1	Any P-No. 4 metal to any metal assigned to P-No. 3 or P-No. 1
Any unassigned metal to the same unassigned metal	The unassigned metal to itself
Any unassigned metal to any P-Number metal	The unassigned metal to any metal assigned to the same P-Number as the qualified metal
Any unassigned metal to any other unassigned metal	The first unassigned metal to the second unassigned metal

QW-430 F-NUMBERS

QW-431 General

The following F-Number grouping of electrodes and welding rods in QW-432 is based essentially on their usability characteristics, which fundamentally determine the ability of welders to make satisfactory welds with a given filler metal. This grouping is made to reduce the number of welding procedure and performance qualifications, where this can logically be done. The grouping does not imply that base metals or filler metals within a group may be indiscriminately substituted for a metal which was used in the qualification test without consideration of the compatibility of the base and filler metals from the standpoint of metallurgical properties, postweld heat treatment design and service requirements, and mechanical properties.

QW-432.1	Steel and Steel Alloys
QW-432.2	Aluminum and Aluminum-Base Alloys
QW-432.3	Copper and Copper-Base Alloys
QW-432.4	Nickel and Nickel-Base Alloys
QW-432.5	Titanium and Titanium Alloys
QW-432.6	Zirconium and Zirconium Alloys
QW-432.7	Hard-Facing Weld Metal Overlay

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QW-432
F-NUMBERS
Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification
	Steel and Steel Alloys	
1	SFA-5.1	EXX20
1	SFA-5.1	EXX22
1	SFA-5.1	EXX24
1	SFA-5.1	EXX27
1	SFA-5.1	EXX28
1	SFA-5.4	EXXX(X)-25
1	SFA-5.4	EXXX(X)-26
1	SFA-5.5	EXX20-X
1	SFA-5.5	EXX27-X
2	SFA-5.1	EXX12
2	SFA-5.1	EXX13
2	SFA-5.1	EXX14
2	SFA-5.1	EXX19
2	SFA-5.5	E(X)XX13-X
3	SFA-5.1	EXX10
3	SFA-5.1	EXX11
3	SFA-5.5	E(X)XX10-X
3	SFA-5.5	E(X)XX11-X
4	SFA-5.1	EXX15
4	SFA-5.1	EXX16
4	SFA-5.1	EXX18
4	SFA-5.1	EXX18M
4	SFA-5.1	EXX48
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-15
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-16
4	SFA-5.4 other than austenitic and duplex	EXXX(X)-17

QW-432 (CONT'D)
F-NUMBERS
Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification
	Steel and Steel Alloys (cont'd)	
4	SFA-5.5	E(X)XX15-X
4	SFA-5.5	E(X)XX16-X
4	SFA-5.5	E(X)XX18-X
4	SFA-5.5	E(X)XX18M
4	SFA-5.5	E(X)XX18M1
5	SFA-5.4 austenitic and duplex	EXXX(X)-15
5	SFA-5.4 austenitic and duplex	EXXX(X)-16
5	SFA-5.4 austenitic and duplex	EXXX(X)-17
6	SFA-5.2	All classifications
6	SFA-5.9	All classifications
6	SFA-5.17	All classifications
6	SFA-5.18	All classifications
6	SFA-5.20	All classifications
6	SFA-5.22	All classifications
6	SFA-5.23	All classifications
6	SFA-5.25	All classifications
6	SFA-5.26	All classifications
6	SFA-5.28	All classifications
6	SFA-5.29	All classifications
6	SFA-5.30	INMs-X
6	SFA-5.30	IN5XX
6	SFA-5.30	IN3XX(X)
	Aluminum and Aluminum Alloys	
21	SFA-5.3	E1100
21	SFA-5.3	E3003
21	SFA-5.10	ER1100
21	SFA-5.10	R1100
21	SFA-5.10	ER1188
21	SFA-5.10	R1188
22	SFA-5.10	ER5183
22	SFA-5.10	R5183
22	SFA-5.10	ER5356
22	SFA-5.10	R5356
22	SFA-5.10	ER5554
22	SFA-5.10	R5554
22	SFA-5.10	ER5556
22	SFA-5.10	R5556
22	SFA-5.10	ER5654
22	SFA-5.10	R5654
23	SFA-5.3	E4043
23	SFA-5.10	ER4009
23	SFA-5.10	R4009
23	SFA-5.10	ER4010
23	SFA-5.10	R4010
23	SFA-5.10	R4011
23	SFA-5.10	ER4043
23	SFA-5.10	R4043
23	SFA-5.10	ER4047
23	SFA-5.10	R4047
23	SFA-5.10	ER4145

QW-432 (CONT'D)
F-NUMBERS
Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification
	Aluminum and Aluminum Alloys (cont'd)	
23	SFA-5.10	R4145
23	SFA-5.10	ER4643
23	SFA-5.10	R4643
24	SFA-5.10	R206.0
24	SFA-5.10	R-C355.0
24	SFA-5.10	R-A356.0
24	SFA-5.10	R357.0
24	SFA-5.10	R-A357.0
25	SFA-5.10	ER2319
25	SFA-5.10	R2319
	Copper and Copper Alloys	
31	SFA-5.6	ECu
31	SFA-5.7	ERCu
32	SFA-5.6	ECuSi
32	SFA-5.7	ERCuSi-A
33	SFA-5.6	ECuSn-A
33	SFA-5.6	ECuSn-C
33	SFA-5.7	ERCuSn-A
34	SFA-5.6	ECuNi
34	SFA-5.7	ERCuNi
34	SFA-5.30	IN67
35	SFA-5.8	RBCuZn-A
35	SFA-5.8	RBCuZn-B
35	SFA-5.8	RBCuZn-C
35	SFA-5.8	RBCuZn-D
36	SFA-5.6	ECuAl-A2
36	SFA-5.6	ECuAl-B
36	SFA-5.7	ERCuAl-A1
36	SFA-5.7	ERCuAl-A2
36	SFA-5.7	ERCuAl-A3
37	SFA-5.6	ECuNiAl
37	SFA-5.6	ECuMnNiAl
37	SFA-5.7	ERCuNiAl
37	SFA-5.7	ERCuMnNiAl
	Nickel and Nickel Alloys	
41	SFA-5.11	ENi-1
41	SFA-5.14	ERNi-1
41	SFA-5.30	IN61
42	SFA-5.11	ENiCu-7
42	SFA-5.14	ERNiCu-7
42	SFA-5.14	ERNiCu-8
42	SFA-5.30	IN60

QW-432 (CONT'D)
F-NUMBERS
Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification
	Nickel and Nickel Alloys (cont'd)	
43	SFA-5.11	ENiCrFe-1
43	SFA-5.11	ENiCrFe-2
43	SFA-5.11	ENiCrFe-3
43	SFA-5.11	ENiCrFe-4
43	SFA-5.11	ENiCrFe-7
43	SFA-5.11	ENiCrFe-9
43	SFA-5.11	ENiCrFe-10
43	SFA-5.11	ENiCrMo-2
43	SFA-5.11	ENiCrMo-3
43	SFA-5.11	ENiCrMo-6
43	SFA-5.11	ENiCrMo-12
43	SFA-5.11	ENiCrCoMo-1
43	SFA-5.14	ERNiCr-3
43	SFA-5.14	ERNiCr-4
43	SFA-5.14	ERNiCr-6
43	SFA-5.14	ERNiCrFe-5
43	SFA-5.14	ERNiCrFe-6
43	SFA-5.14	ERNiCrFe-7
43	SFA-5.14	ERNiCrFe-8
43	SFA-5.14	ERNiCrFe-11
43	SFA-5.14	ERNiCrCoMo-1
43	SFA-5.14	ERNiCrMo-2
43	SFA-5.14	ERNiCrMo-3
43	SFA-5.30	IN6A
43	SFA-5.30	IN62
43	SFA-5.30	IN82
44	SFA-5.11	ENiMo-1
44	SFA-5.11	ENiMo-3
44	SFA-5.11	ENiMo-7
44	SFA-5.11	ENiMo-8
44	SFA-5.11	ENiMo-9
44	SFA-5.11	ENiMo-10
44	SFA-5.11	ENiCrMo-4
44	SFA-5.11	ENiCrMo-5
44	SFA-5.11	ENiCrMo-7
44	SFA-5.11	ENiCrMo-10
44	SFA-5.11	ENiCrMo-13
44	SFA-5.11	ENiCrMo-14
44	SFA-5.14	ERNiMo-1
44	SFA-5.14	ERNiMo-2
44	SFA-5.14	ERNiMo-3
44	SFA-5.14	ERNiMo-7 (B2)
44	SFA-5.14	ERNiMo-8
44	SFA-5.14	ERNiMo-9
44	SFA-5.14	ERNiMo-10
44	SFA-5.14	ERNiCrMo-4
44	SFA-5.14	ERNiCrMo-7 (Alloy C4)
44	SFA-5.14	ERNiCrMo-10
44	SFA-5.14	ERNiCrMo-13
44	SFA-5.14	ERNiCrMo-14
44	SFA-5.14	ERNiCrWMo-1
45	SFA-5.11	ENiCrMo-1
45	SFA-5.11	ENiCrMo-9

QW-432 (CONT'D)
F-NUMBERS
Grouping of Electrodes and Welding Rods for Qualification

F-No.	ASME Specification	AWS Classification
	Nickel and Nickel Alloys (cont'd)	
45	SFA-5.11	ENiCrMo-11
45	SFA-5.14	ERNiCrMo-1
45	SFA-5.14	ERNiCrMo-8
45	SFA-5.14	ERNiCrMo-9
45	SFA-5.14	ERNiCrMo-11
45	SFA-5.14	ERNiFeCr-1
	Titanium and Titanium Alloys	
51	SFA-5.16	ERTi-1
51	SFA-5.16	ERTi-2
51	SFA-5.16	ERTi-3
51	SFA-5.16	ERTi-4
52	SFA-5.16	ERTi-7
53	SFA-5.16	ERTi-9
53	SFA-5.16	ERTi-9ELI
54	SFA-5.16	ERTi-12
55	SFA-5.16	ERTi-5
55	SFA-5.16	ERTi-5ELI
55	SFA-5.16	ERTi-6
55	SFA-5.16	ERTi-6ELI
55	SFA-5.16	ERTi-15
	Zirconium and Zirconium Alloys	
61	SFA-5.24	ERZr2
61	SFA-5.24	ERZr3
61	SFA-5.24	ERZr4
	Hard-Facing Weld Metal Overlay	
71	SFA-5.13	All classifications
72	SFA-5.21	All classifications

QW-450 SPECIMENS

QW-451 Procedure Qualification Thickness Limits and Test Specimens

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QW-451.1
GROOVE-WELD TENSION TESTS AND TRANSVERSE-BEND TESTS

Thickness T of Test Coupon Welded, in.	Range of Thickness T of Base Metal Qualified, in. [Notes (1) and (4)]		Thickness t of Deposited Weld Metal Qualified, in. [Notes (1) and (4)]	Type and Number of Tests Required (Tension and Guided-Bend Tests) [Note (4)]			
	Min.	Max.	Max.	Tension QW-150	Side Bend QW-160	Face Bend QW-160	Root Bend QW-160
Less than $1/16$	T	$2T$	$2t$	2	. . .	2	2
$1/16$ to $3/8$, incl.	$1/16$	$2T$	$2t$	2	Note (3)	2	2
Over $3/8$, but less than $3/4$	$3/16$	$2T$	$2t$	2	Note (3)	2	2
$3/4$ to less than $1\,1/2$	$3/16$	$2T$	$2t$ when $t < 3/4$	2 (5)	4	. . .	. . .
$3/4$ to less than $1\,1/2$	$3/16$	$2T$	$2T$ when $t \geq 3/4$	2 (5)	4	. . .	. . .
$1\,1/2$ and over	$3/16$	8 (2)	$2t$ when $t < 3/4$	2 (5)	4	. . .	. . .
$1\,1/2$ and over	$3/16$	8 (2)	8 (2) when $t \geq 3/4$	2 (5)	4	. . .	. . .

NOTES:
(1) See QW-403 (.2, .3, .6, .9, .10), QW-404.32, and QW-407.4 for further limits on range of thickness qualified. Also, see QW-202 (.2, .3, .4) for allowable exceptions.
(2) For the welding processes of QW-403.7 only; otherwise per Note (1) or $2T$, or $2t$, whichever is applicable.
(3) Four side-bend tests may be substituted for the required face- and root-bend tests, when thickness T is $3/8$ in. and over.
(4) For combination of welding procedures, see QW-200.4.
(5) See QW-151 (.1, .2, .3) for details on multiple specimens when coupon thicknesses are over 1 in.

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QW-451.2
GROOVE-WELD TENSION TESTS AND LONGITUDINAL-BEND TESTS

Thickness T of Test Coupon Welded, in.	Range of Thickness T of Base Metal Qualified, in. [Notes (1) and (2)]		Thickness t of Deposited Weld Metal Qualified, in. [Notes (1) and (2)]	Type and Number of Tests Required (Tension and Guided-Bend Tests) [Note (2)]		
	Min.	Max.	Max.	Tension QW-150	Face Bend QW-160	Root Bend QW-160
Less than $1/16$	T	$2T$	$2t$	2	2	2
$1/16$ to $3/8$, incl.	$1/16$	$2T$	$2t$	2	2	2
Over $3/8$	$3/16$	$2T$	$2t$	2	2	2

NOTES:
(1) See QW-403 (.2, .3, .6, .7, .9, .10), QW-404.32, and QW-407.4 for further limits on range of thickness qualified. These are also applicable to deposited weld metal thicknesses. Also, see QW-202 (.2, .3, .4) for allowable exceptions.
(2) For combination of welding procedures, see QW-200.4.

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QW-451.3
FILLET-WELD TESTS[1]

Type of Joint	Thickness of Test Coupons as Welded, in.	Range Qualified	Type and Number of Tests Required [[QW-462.4(a) or QW-462.4(d)]] Macro
Fillet	Per QW-462.4(a)	All fillet sizes on all base metal thicknesses and all diameters	5
Fillet	Per QW-462.4(d)		4

NOTE:
(1) A production assembly mockup may be substituted in accordance with QW-181.1.1. When a production assembly mockup is used, the range qualified shall be limited to the fillet weld size, base metal thickness, and configuration of the mockup. Alternatively, multiple production assembly mockups may be qualified. The range of thickness of the base metal qualified shall be no less than the thickness of the thinner member tested and no greater than the thickness of the thicker member tested. The range for fillet weld sizes qualified shall be limited to no less than the smallest fillet weld tested and no greater than the largest fillet weld tested. The configuration of production assemblies shall be the same as that used in the production assembly mockup.

QW-451.4
FILLET WELDS QUALIFIED BY GROOVE-WELD TESTS

Thickness *T* of Test Coupon (Plate or Pipe) as Welded	Range Qualified	Type and Number of Tests Required
All groove tests	All fillet sizes on all base metal thicknesses and all diameters	Fillet welds are qualified when the groove weld is qualified in accordance with either QW-451.1 or QW-451.2 (see QW-202.2)

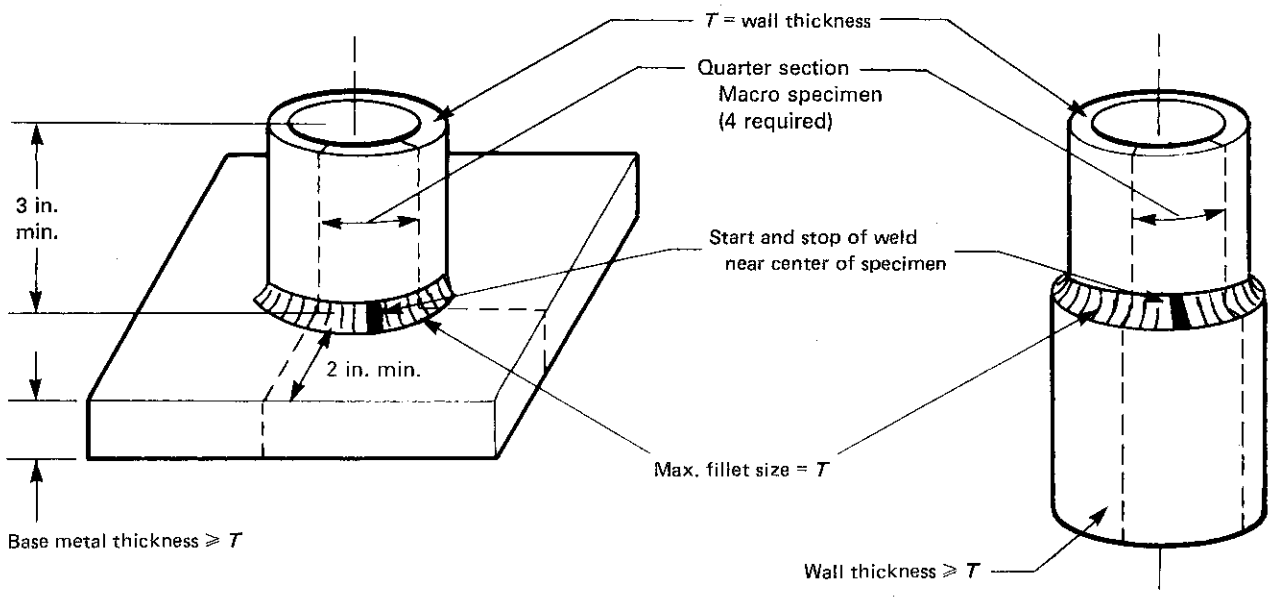
QW-452 Performance Qualification Thickness Limits and Test Specimens

A00

QW-452.1
TRANSVERSE-BEND TESTS

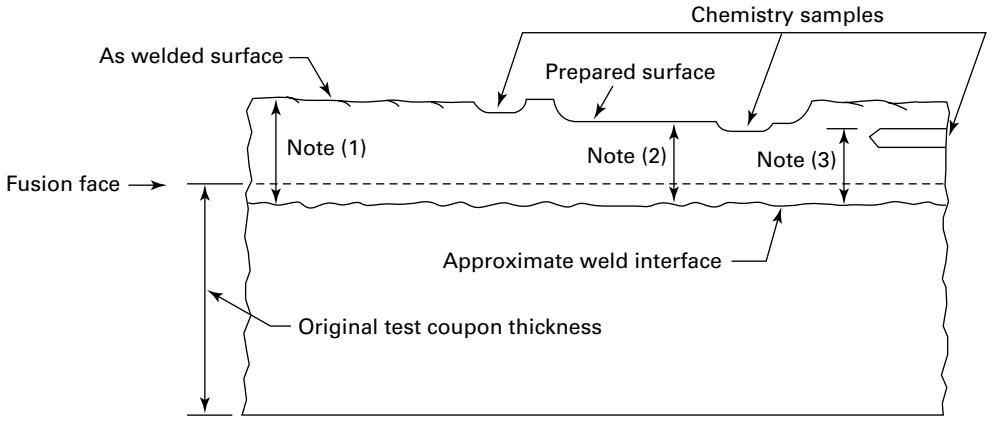
Type of Joint	Thickness of Test Coupon Welded, in. [Note (1)]	Thickness t of Deposited Weld Metal Qualified, in. [Note (2)] (See QW-310.1) Max.	Type and Number of Tests Required (Guided-Bend Tests) [Notes (3), (4), (8)] Side Bend QW-462.2	Face Bend QW-462.3(a)	Root Bend [Note (5)] QW-462.3(a)
Groove	Up to $^3/_8$, incl.	$2t$	Note (6)	1	1
Groove	Over $^3/_8$	$2t$	Note (7)	1	1
Groove	$^1/_2$ and over [Note (9)]	Max. to be welded	2	. . .	. . .

NOTES:
(1) When using one, two, or more welders, the thickness t of the deposited weld metal for each welder with each process shall be determined and used individually in the Thickness column.
(2) Two or more pipe test coupons of different thicknesses may be used to determine the deposited weld metal thickness qualified and that thickness may be applied to production welds to the smallest diameter for which the welder is qualified in accordance with QW-452.3.
(3) Thickness of test coupon of $^1/_2$ in. or over shall be used for qualifying a combination of three or more welders each of which may use the same or a different welding process.
(4) To qualify for positions 5G and 6G, as prescribed in QW-302.3, two root and two face-bend specimens or four side bend specimens, as applicable to the test coupon thickness, are required.
(5) Face- and root-bend tests may be used to qualify a combination test of:
(a) one welder using two welding processes; or
(b) two welders using the same or a different welding process.
(6) For a $^3/_8$ in. thick coupon, a side-bend test may be substituted for each of the required face- and root-bend tests.
(7) A side-bend test may be substituted for each of the required face- and root-bend tests.
(8) Test coupons shall be visually examined per QW-302.4.
(9) Test coupon weld deposit shall also consist of a minimum of three layers of weld metal.



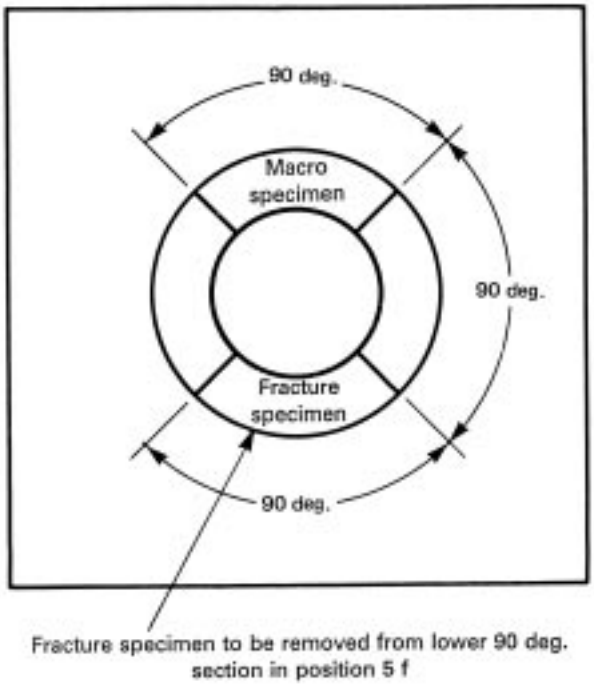
GENERAL NOTES:
(a) Either pipe-to-plate or pipe-to-pipe may be used as shown.
(b) Macro test:
(1) The fillet shall show fusion at the root of the weld but not necessarily beyond the root.
(2) The weld metal and the heat affected zone shall be free of cracks.

QW-462.4(d) FILLET WELDS IN PIPE — PROCEDURE

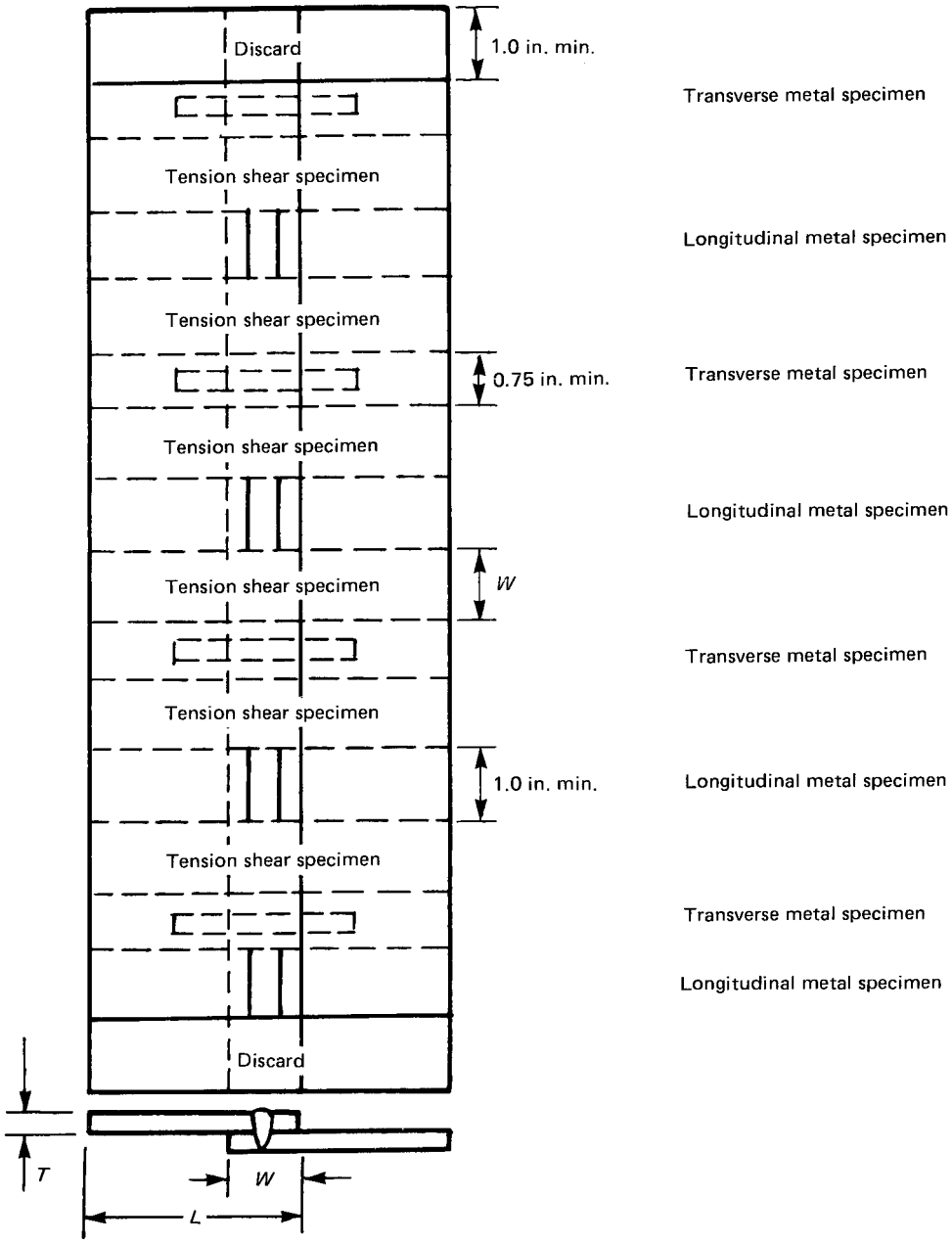


NOTES:
(1) When a chemical analysis or hardness test is conducted on the as welded surface, the distance from the approximate weld interface to the final as welded surface shall become the minimum qualified overlay thickness. The chemical analysis may be performed directly on the as welded surface or on chips of material taken from the as welded surface.
(2) When a chemical analysis or hardness test is conducted after material has been removed from the as welded surface, the distance from the approximate weld interface to the prepared surface shall become the minimum qualified overlay thickness. The chemical analysis may be made directly on the prepared surface or from chips removed from the prepared surface.
(3) When a chemical analysis test is conducted on material removed by a horizontal drilled sample, the distance from the approximate weld interface to the uppermost side of the drilled cavity shall become the minimum qualified overlay thickness. The chemical analysis shall be performed on chips of material removed from the drilled cavity.

A00 QW-462.5(a) CHEMICAL ANALYSIS AND HARDNESS SPECIMEN CORROSION-RESISTANT AND HARDFACING WELD METAL OVERLAY

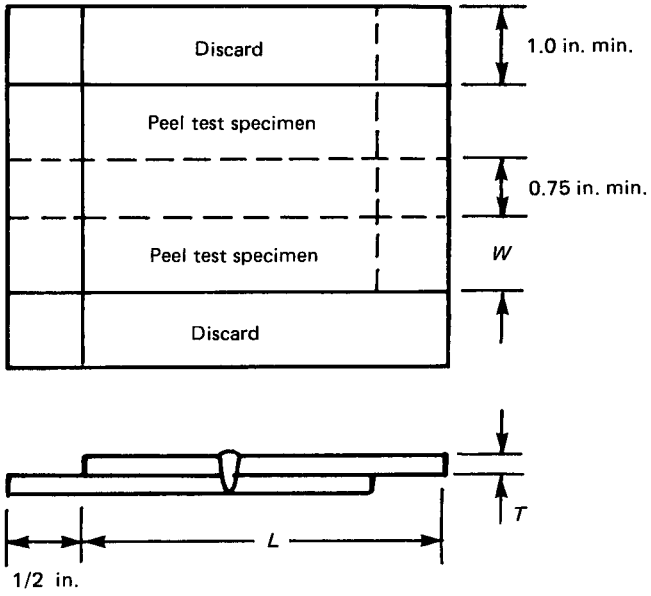

90 deg.
Macro specimen
90 deg.
Fracture specimen
90 deg.
Fracture specimen to be removed from lower 90 deg. section in position 5 f

QW-463.2(h) PERFORMANCE QUALIFICATION



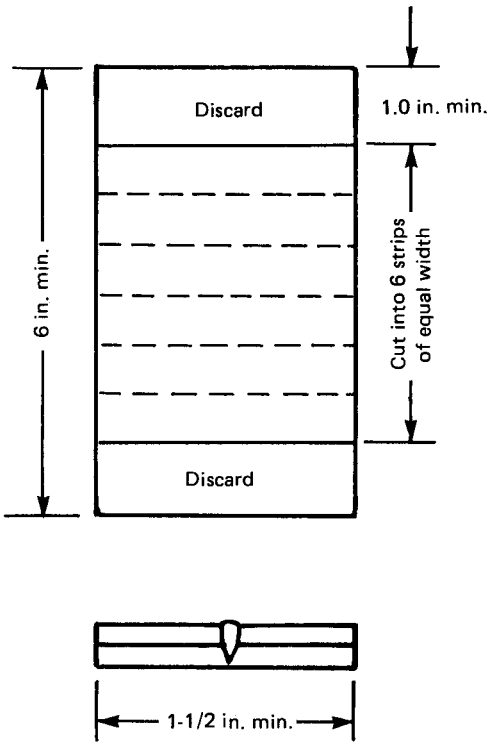
Thickness of Thinner Sheet *T*, in.	Specimen Width *W*, in.	Recommended Length *L*, in.
Up to 0.029	5/8	3
0.031 to 0.050	3/4	3
0.051 to 0.100	1	4
0.101 to 0.130	1-1/4	5
0.131 to 0.190	1-1/2	5
0.191 and over	2	6

QW-464.1 PROCEDURE QUALIFICATION TEST COUPON AND TEST SPECIMENS



Thickness of Thinner Sheet *T*, in.	Specimen Width *W*, in.	Recommended Length *L*, in.
Up to 0.029	5/8	2
0.030 to 0.058	1	3
0.059 to 0.125	1-1/2	4

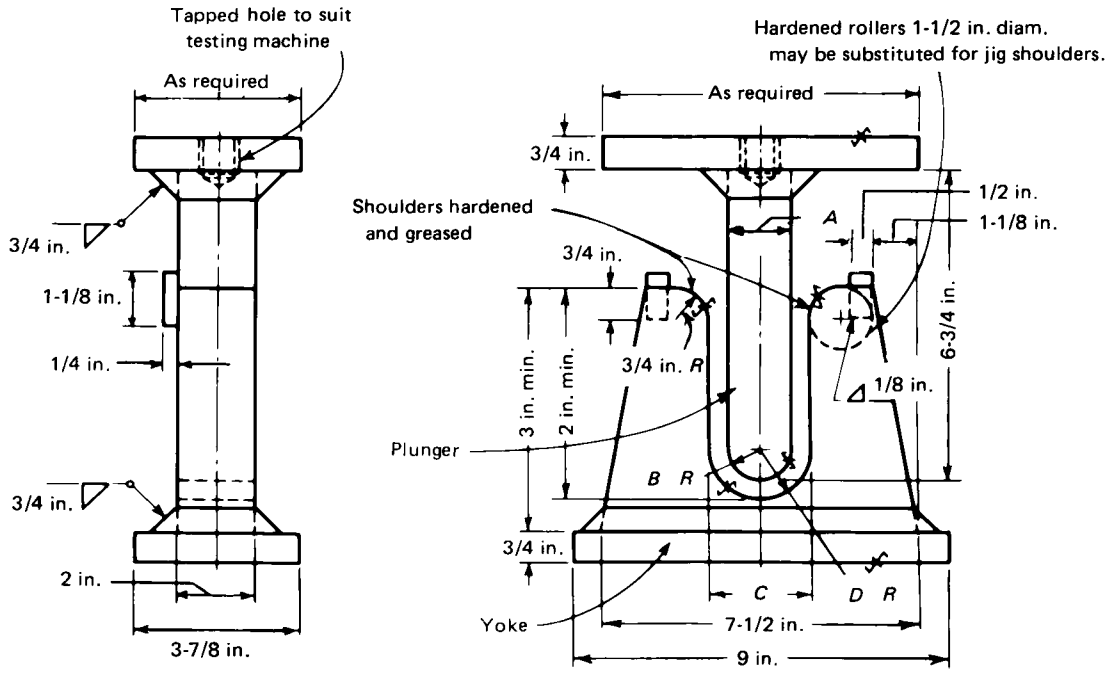
(a) Peel Test Coupon and Specimens



(b) Metallurgical Examination Coupon and Transverse Specimens

QW-464.2 PERFORMANCE QUALIFICATION TEST COUPONS AND TEST SPECIMENS

QW-466 Test Jigs



Material	Thickness of Specimen, in.	*A*, in.	*B*, in.	*C*, in.	*D*, in.
P-No. 23 to P-No. 21 through P-No. 25; P-No. 21 through P-No. 25 with F-No. 23; P-No. 35; any P-No. metal with F-No. 33, 36, or 37	1/8 t = 1/8 or less	2-1/16 16-1/2t	1-1/32 8-1/4t	2-3/8 18-1/2t + 1/16	1-3/16 9-1/4t + 1/32
P-No. 11; P-No. 25 to P-No. 21 or P-No. 22 or P-No. 25	3/8 t = 3/8 or less	2-1/2 6-2/3t	1-1/4 3-1/3t	3-3/8 8-2/3t + 1/8	1-11/16 4-1/3t + 1/16
P-No. 51	3/8 t = 3/8 or less	3 8t	1-1/2 4t	3-7/8 10t + 1/8	1-15/16 5t + 1/16
P-No. 52, P-No. 53, P-No. 61, P-No. 62	3/8 t = 3/8 or less	3-3/4 10t	1-7/8 5t	4-5/8 12t + 1/8	2-5/16 6t + 1/16
All others with greater than or equal to 20% elongation	3/8 t = 3/8 or less	1-1/2 4t	3/4 2t	2-3/8 6t + 1/8	1-3/16 3t + 1/16
All others with less than 20% elongation	t = (see Note b)	32-7/8t, max.	16-7/16t, max.	34-7/8t + 1/16, max.	17-7/16t + 1/32, max.

GENERAL NOTES:

(a) For P-Numbers, see QW-422; for F-Numbers, see QW-432.

(b) The dimensions of the test jig shall be such as to give the bend test specimen a calculated percent outer fiber elongation equal to at least that of the base material with the lower minimum elongation as specified in the base material specification.

$$\text{percent outer fiber elongation} = \frac{100t}{A + t}$$

The following formula is provided for convenience in calculating the bend specimen thickness:

$$\text{thickness of specimen } (t) = \frac{A \times \text{percent elongation}}{[100 - (\text{percent elongation})]}$$

(c) For guided-bend jig configuration, see QW-466.2, QW-466.3, and QW-466.4.

(d) The weld and heat affected zone, in the case of a transverse weld bend specimen, shall be completely within the bend portion of the specimen after testing.

A99 QW-466.1 TEST JIG DIMENSIONS

QW-470 ETCHING — PROCESSES AND REAGENTS

QW-471 General

The surfaces to be etched should be smoothed by filing, machining, or grinding on metallographic papers. With different alloys and tempers, the etching period will vary from a few seconds to several minutes, and should be continued until the desired contrast is obtained. As a protection from the fumes liberated during the etching process, this work should be done under a hood. After etching, the specimens should be thoroughly rinsed and then dried with a blast of warm air. Coating the surface with a thin clear lacquer will preserve the appearance.

QW-472 For Ferrous Metals

Etching solutions suitable for carbon and low alloy steels, together with directions for their use, are suggested as follows.

QW-472.1 Hydrochloric Acid. Hydrochloric (muriatic) acid and water, equal parts, by volume. The solution should be kept at or near the boiling temperature during the etching process. The specimens are to be immersed in the solution for a sufficient period of time to reveal all lack of soundness that might exist at their cross-sectional surfaces.

QW-472.2 Ammonium Persulfate. One part of ammonium persulfate to nine parts of water, by weight. The solution should be used at room temperature, and should be applied by vigorously rubbing the surface to be etched with a piece of cotton saturated with the solution. The etching process should be continued until there is a clear definition of the structure in the weld.

QW-472.3 Iodine and Potassium Iodide. One part of powdered iodine (solid form), two parts of powdered potassium iodide, and ten parts of water, all by weight. The solution should be used at room temperature, and brushed on the surface to be etched until there is a clear definition or outline of the weld.

QW-472.4 Nitric Acid. One part of nitric acid and three parts of water, by volume.

CAUTION: Always pour the acid into the water. Nitric acid causes bad stains and severe burns.

The solution may be used at room temperature and applied to the surface to be etched with a glass stirring rod. The specimens may also be placed in a boiling solution of the acid, but the work should be done in a well-ventilated room. The etching process should be continued for a sufficient period of time to reveal all lack of soundness that might exist at the cross-sectional surfaces of the weld.

QW-473 For Nonferrous Metals

The following etching reagents and directions for their use are suggested for revealing the macrostructure.

QW-473.1 Aluminum and Aluminum-Base Alloys

Hydrochloric acid (concentrated)	15 ml
Hydrofluoric acid (48%)	10 ml
Water	85 ml

This solution is to be used at room temperature, and etching is accomplished by either swabbing or immersing the specimen.

QW-473.2 For Copper and Copper-Base Alloys: Cold Concentrated Nitric Acid. Etching is accomplished by either flooding or immersing the specimen for several seconds under a hood. After rinsing with a flood of water, the process is repeated with a 50-50 solution of concentrated nitric acid and water.

In the case of the silicon bronze alloys, it may be necessary to swab the surface to remove a white (SiO_2) deposit.

QW-473.3 For Nickel and Nickel-Base Alloys

Material	Formula
Nickel	Nitric Acid or Lepito's Etch
Low Carbon Nickel	Nitric Acid or Lepito's Etch
Nickel–Copper (400)	Nitric Acid or Lepito's Etch
Nickel–Chromium–Iron (600 and 800)	Aqua Regia or Lepito's Etch

MAKEUP OF FORMULAS FOR AQUA REGIA AND LEPITO'S ETCH

	Aqua Regia [(1), (3)]	Lepito's Etch [(2), (3)]
Nitric Acid, Concentrated — HNO_3	1 part	3 ml
Hydrochloric Acid, Concentrated — HCL	2 parts	10 ml
Ammonium Sulfate — $(NH_4)_2(SO_4)$	. . .	1.5 g
Ferric Chloride — $FeCl_3$	. . .	2.5 g
Water	. . .	7.5 ml

NOTES:
(1) Warm the parts for faster action.
(2) Mix solution as follows:
  (a) Dissolve $(NH_4)_2(SO_4)$ in H_2O.
  (b) Dissolve powdered $FeCl_3$ in warm HCl.
  (c) Mix (a) and (b) above and add HNO_3.
(3) Etching is accomplished by either swabbing or immersing the specimen.

QW-473.4 For Titanium

	Kroll's Etch	Keller's Etch
Hydrofluoric acid (48%)	1 to 3 ml	½ ml
Nitric acid (concentrated)	2 to 6 ml	2½ ml
Hydrochloric Acid (concentrated)	...	1½ ml
Water	To make 100 ml	To make 100 ml

QW-473.5 For Zirconium

Hydrofluoric acid	3 ml
Nitric acid (concentrated)	22 ml
Water	22 ml

Apply by swab and rinse in cold water.

These are general purpose etchants which are applied at room temperature by swabbing or immersion of the specimen.

QW-490 DEFINITIONS

A99 QW/QB-491 General

Definitions of the more common terms relating to welding/brazing are defined in QW/QB-492. These are identical to, or substantially in agreement with the definitions of the American Welding Society document, AWS A3.0, Standard Welding Terms and Definitions. There are terms listed that are specific to ASME Section IX and are not presently defined in AWS A3.0. Several definitions have been modified slightly from A3.0 so as to better define the context/intent as used in ASME Section IX.

A99 A00 QW/QB-492 Definitions

arc seam weld — a seam weld made by an arc welding process.

arc spot weld — a spot weld made by an arc welding process

arc strike — any inadvertent discontinuity resulting from an arc, consisting of any localized remelted metal, heat-affected metal, or change in the surface profile of any metal object. The arc may be caused by arc welding electrodes, magnetic inspection prods, or frayed electrical cable.

arc welding — a group of welding processes wherein coalescence is produced by heating with an arc or arcs, with or without the application of pressure, and with or without the use of filler metal

as-brazed — adj. pertaining to the condition of brazements after brazing, prior to any subsequent thermal, mechanical, or chemical treatments

as-welded — adj. pertaining to the condition of weld metal, welded joints, and weldments after welding but prior to any subsequent thermal, mechanical, or chemical treatments

backgouging — the removal of weld metal and base metal from the weld root side of a welded joint to facilitate complete fusion and complete joint penetration upon subsequent welding from that side

backhand welding — a welding technique in which the welding torch or gun is directed opposite to the progress of welding

backing — a material placed at the root of a weld joint for the purpose of supporting molten weld metal so as to facilitate complete joint penetration. The material may or may not fuse into the joint. See retainer.

backing gas — a gas, such as argon, helium, nitrogen, or reactive gas, which is employed to exclude oxygen from the root side (opposite from the welding side) of weld joints

base metal — the metal or alloy that is welded, brazed, or cut

bond line (brazing and thermal spraying) — the cross section of the interface between a braze or thermal spray deposit and the substrate

braze — a joint produced by heating an assembly to suitable temperatures and by using a filler metal having a liquidus above 840°F and below the solidus of the base materials. The filler metal is distributed between the closely fitted surfaces of the joint by capillary action.

brazer — one who performs a manual or semiautomatic brazing operation

brazing — a group of metal joining processes which produces coalescence of materials by heating them to a suitable temperature, and by using a filler metal having a liquidus above 840°F and below the solidus of the base materials. The filler metal is distributed between the closely fitted surfaces of the joint by capillary action.

brazing, automatic — brazing with equipment which performs the brazing operation without constant observation and adjustment by a brazing operator. The equipment may or may not perform the loading and unloading of the work.

brazing, block (BB) — a brazing process that uses heat from heated blocks applied to the joint. This is an obsolete or seldom used process.

brazing, dip (DB) — a brazing process in which the heat required is furnished by a molten chemical or metal bath. When a molten chemical bath is used, the bath may act as a flux; when a molten metal bath is used, the bath provides the filler metal.

brazing, furnace (FB) — a brazing process in which the workpieces are placed in a furnace and heated to the brazing temperature

brazing, induction (IB) — a brazing process that uses heat from the resistance of the workpieces to induced electric current

brazing, machine — brazing with equipment which performs the brazing operation under the constant observation and control of a brazing operator. The equipment may or may not perform the loading and unloading of the work.

brazing, manual — a brazing operation performed and controlled completely by hand. See automatic brazing and machine brazing.

brazing, resistance (RB) — a brazing process that uses heat from the resistance to electric current flow in a circuit of which the workpieces are a part

brazing, semiautomatic — brazing with equipment which controls only the brazing filler metal feed. The advance of the brazing is manually controlled.

brazing, torch (TB) — a brazing process that uses heat from a fuel gas flare

brazing operator — one who operates machine or automatic brazing equipment

brazing temperature — the temperature to which the base metal(s) is heated to enable the filler metal to wet the base metal(s) and form a brazed joint

brazing temperature range — the temperature range within which brazing can be conducted

build-up of base metal/restoration of base metal thickness — this is the application of a weld material to a base metal so as to restore the design thickness and/or structural integrity. This build-up may be with a chemistry different from the base metal chemistry which has been qualified via a standard butt welded test coupon. Also, may be called base metal repair or buildup.

butt joint — a joint between two members aligned approximately in the same plane

buttering — the addition of material, by welding, on one or both faces of a joint, prior to the preparation of the joint for final welding, for the purpose of providing a suitable transition weld deposit for the subsequent completion of the joint

clad brazing sheet — a metal sheet on which one or both sides are clad with brazing filler metal

coalescence — the growing together or growth into one body of the materials being joined

complete fusion — fusion which has occurred over the entire base material surfaces intended for welding, and between all layers and beads

composite — a material consisting of two or more discrete materials with each material retaining its physical identity

consumable insert — filler metal that is placed at the joint root before welding, and is intended to be completely fused into the root to become part of the weld

contact tube — a device which transfers current to a continuous electrode

corner joint — a joint between two members located approximately at right angles to each other in the form of an L

coupon — see test coupon

crack — a fracture-type discontinuity characterized by a sharp tip and high ratio of length and width to opening displacement

defect — a discontinuity or discontinuities that by nature or accumulated effect (for example, total crack length) render a part or product unable to meet minimum applicable acceptance standards or specifications. This term designates rejectability. See also discontinuity and flaw.

direct current electrode negative (DCEN) — the arrangement of direct current arc welding leads in which the electrode is the negative pole and the workpiece is the positive pole of the welding arc

direct current electrode positive (DCEP) — the arrangement of direct current arc welding leads in which the electrode is the positive pole and the workpiece is the negative pole of the welding arc

discontinuity — an interruption of the typical structure of a material, such as a lack of homogeneity in its mechanical, metallurgical, or physical characteristics. A discontinuity is not necessarily a defect. See also defect and flaw.

double-welded joint — a joint that is welded from both sides

double-welded lap joint — a lap joint in which the overlapped edges of the members to be joined are welded along the edges of both members

dwell — the time during which the energy source pauses at any point in each oscillation

electrode, arc welding — a component of the welding circuit through which current is conducted

electrode, bare — a filler metal electrode that has been produced as a wire, strip, or bar with no coating or covering other than that incidental to its manufacture or preservation

electrode, carbon — a nonfiller material electrode used in arc welding and cutting, consisting of a carbon or graphite rod, which may be coated with copper or other materials

electrode, composite — a generic term of multicomponent filler metal electrodes in various physical forms, such as stranded wires, tubes, and covered electrodes

electrode, covered — a composite filler metal electrode consisting of a core of a bare electrode or metal-cored electrode to which a covering sufficient to provide a slag layer on the weld metal has been applied. The covering may contain materials providing such functions as shielding from the atmosphere, deoxidation, and arc stabilization, and can serve as a source of metallic additions to the weld.

electrode, electroslag welding — a filler metal component of the welding circuit through which current is conducted between the electrode guiding member and the molten slag

NOTE: Bare electrodes and composite electrodes as defined under arc welding electrode are used for electroslag welding. A consumable guide may also be used as part of the electroslag welding electrode system.

electrode, emissive — a filler metal electrode consisting of a core of a bare electrode or a composite electrode to which a very light coating has been applied to produce a stable arc

electrode, flux-cored — a composite filler metal electrode consisting of a metal tube or other hollow configuration containing ingredients to provide such functions as shielding atmosphere, deoxidation, arc stabilization, and slag formation. Alloying materials may be included in the core. External shielding may or may not be used.

electrode, lightly coated — a filler metal electrode consisting of a metal wire with a light coating applied subsequent to the drawing operation, primarily for stabilizing the arc

electrode, metal — a filler or nonfiller metal electrode used in arc welding and cutting that consists of a metal wire or rod that has been manufactured by any method and that is either bare or covered

electrode, metal-cored — a composite filler metal electrode consisting of a metal tube or other hollow configuration containing alloying ingredients. Minor amounts of ingredients providing such functions as arc stabilization and fluxing of oxides may be included. External shielding gas may or may not be used.

electrode, resistance welding — the part of a resistance welding machine through which the welding current and, in most cases, force are applied directly to the workpiece. The electrode may be in the form of a rotating wheel, rotating roll, bar, cylinder, plate, clamp, chuck, or modification thereof.

electrode, stranded — a composite filler metal electrode consisting of stranded wires which may mechanically enclose materials to improve properties, stabilize the arc, or provide shielding

electrode, tungsten — a nonfiller metal electrode used in arc welding, arc cutting, and plasma spraying, made principally of tungsten

face feed — the application of filler metal to the face side of a joint

ferrite number — an arbitrary, standardized value designating the ferrite content of an austenitic stainless steel weld metal. It should be used in place of percent ferrite or volume percent ferrite on a direct one-to-one replacement basis. See the latest edition of AWS A4.2, Standard Procedures for Calibrating Magnetic Instruments to Measure the Delta Ferrite Content of Austenitic Stainless Steel Weld Metal.

filler metal — the metal or alloy to be added in making a welded, brazed, or soldered joint

filler metal, brazing — the metal or alloy used as a filler metal in brazing, which has a liquidus above 450°C (840°F) and below the solidus of the base metal

filler metal, powder — filler metal in particle form

filler metal, supplemental — in electroslag welding or in a welding process in which there is an arc between one or more consumable electrodes and the workpiece, a powder, solid, or composite material that is introduced into the weld other than the consumable electrode(s)

fillet weld — a weld of approximately triangular cross section joining two surfaces approximately at right angles to each other in a lap joint, tee joint, or corner joint

flaw — an undesirable discontinuity. See also defect.

flux (welding/brazing) — a material used to dissolve, prevent, or facilitate the removal of oxides or other undesirable surface substances. It may act to stabilize the arc, shield the molten pool, and may or may not evolve shielding gas by decomposition.

flux, active (SAW) — a flux from which the amount of elements deposited in the weld metal is dependent upon the welding conditions, primarily arc voltage

flux, alloy (SAW) — a flux which provides alloying elements in the weld metal deposit

flux, neutral (SAW) — a flux which will not cause a significant change in the weld metal composition when there is a large change in the arc voltage

flux cover — metal bath dip brazing and dip soldering. A layer of molten flux over the molten filler metal bath.

forehand welding — a welding technique in which the welding torch or gun is directed toward the progress of welding

frequency — the completed number of cycles which the oscillating head makes in 1 min or other specified time increment

fuel gas — a gas such as acetylene, natural gas, hydrogen, propane, stabilized methylacetylene propadiene, and other fuels normally used with oxygen in one of the oxyfuel processes and for heating

fused spray deposit (thermal spraying) — a self-fluxing thermal spray deposit which is subsequently heated to coalescence within itself and with the substrate

fusion (fusion welding) — the melting together of filler metal and base metal, or of base metal only, to produce a weld

fusion face — a surface of the base metal that will be melted during welding

fusion line — a non-standard term for weld interface

gas backing — see backing gas

globular transfer (arc welding) — a type of metal transfer in which molten filler metal is transferred across the arc in large droplets

groove weld — a weld made in a groove formed within a single member or in the groove between two members to be joined. The standard types of groove weld are as follows:

square groove weld
single-Vee groove weld
single-bevel groove weld
single-U groove weld
single-J groove weld
single-flare-bevel groove weld
single-flare-Vee groove weld
double-Vee groove weld
double-bevel groove weld
double-U groove weld
double-J groove weld
double-flare-bevel groove weld
double-flare-Vee groove weld

heat-affected zone — that portion of the base metal which has not been melted, but whose mechanical properties or microstructures have been altered by the heat of welding or cutting

interpass temperature — the highest temperature in the weld joint immediately prior to welding, or in the case of multiple pass welds, the highest temperature in the section of the previously deposited weld metal, immediately before the next pass is started

joint — the junction of members or the edges of members which are to be joined or have been joined

joint penetration — the distance the weld metal extends from the weld face into a joint, exclusive of weld reinforcement

keyhole welding — a technique in which a concentrated heat source penetrates partially or completely through a workpiece, forming a hole (keyhole) at the leading edge of the weld pool. As the heat source progresses, the molten metal fills in behind the hole to form the weld bead.

lap or overlap — the distance measured between the edges of two plates when overlapping to form the joint

lap joint — a joint between two overlapping members in parallel planes

lower transformation temperature — the temperature at which austenite begins to form during heating

melt-in — a technique of welding in which the intensity of a concentrated heat source is so adjusted that a weld pass can be produced from filler metal added to the leading edge of the molten weld metal

oscillation — an alternating motion relative to the direction of travel of welding, brazing, soldering, thermal cutting, or thermal spray device

overlay — a non-standard term, used in Section IX, for surfacing. See hard-facing and corrosion-resistant overlay.

overlay, corrosion-resistant weld metal — deposition of one or more layers of weld metal to the surface of a base material in an effort to improve the corrosion resistance properties of the surface. This would be applied at a level above the minimum design thickness as a nonstructural component of the overall wall thickness.

overlay, hard-facing weld metal — deposition of one or more layers of weld metal to the surface of a material in an effort to improve the wear resistance properties of the surface. This would be applied at a level above the minimum design thickness as a nonstructural component of the overall wall thickness.

pass — a single progression of a welding or surfacing operation along a joint, weld deposit, or substrate. The result of a pass is a weld bead or layer.

pass, cover — a final or cap pass(es) on the face of a weld

pass, wash — pass to correct minor surface aberrations and/or prepare the surface for nondestructive testing

peel test — a destructive method of testing that mechanically separates a lap joint by peeling

peening — the mechanical working of metals using impact blows

performance qualification — the demonstration of a welder's or welding operator's ability to produce welds meeting prescribed standards

plug weld — a weld made in a circular, or other geometrically shaped hole (like a slot weld) in one member of a lap or tee joint, joining that member to the other. The walls of the hole may or may not be parallel, and the hole may be partially or completely filled with weld metal. (A fillet-welded hole or spot weld should not be construed as conforming to this definition.)

polarity, reverse — the arrangement of direct current arc welding leads with the work as the negative pole and the electrode as the positive pole of the welding arc; a synonym for direct current electrode positive

polarity, straight — the arrangement of direct current arc welding leads in which the work is the positive pole and the electrode is the negative pole of the welding arc; a synonym for direct current electrode negative

postbraze heat treatment — any heat treatment subsequent to brazing

postheating — the application of heat to an assembly after welding, brazing, soldering, thermal spraying, or thermal cutting

postweld heat treatment — any heat treatment subsequent to welding

powder — see filler metal, powder

preheat maintenance — practice of maintaining the minimum specified preheat temperature, or some specified higher temperature for some required time interval after welding or thermal spraying is finished or until post weld heat treatment is initiated

preheat temperature — the minimum temperature in the weld joint preparation immediately prior to the welding; or in the case of multiple pass welds, the minimum temperature in the section of the previously deposited weld metal, immediately prior to welding

preheating — the application of heat to the base metal immediately before a welding or cutting operation to achieve a specified minimum preheat temperature

pulsed power welding — any arc welding method in which the power is cyclically programmed to pulse so that effective but short duration values of a parameter can be utilized. Such short duration values are significantly different from the average value of the parameter. Equivalent terms are pulsed voltage or pulsed current welding. See also pulsed spray welding.

pulsed spray welding — an arc welding process variation in which the current is pulsed to utilize the advantages of the spray mode of metal transfer at average currents equal to or less than the globular to spray transition current

rabbet joint — typical design is indicated in QB-462.1(c), QB-462.4, QB-463.1(c), and QB-463.2(a)

retainer — nonconsumable material, metallic or nonmetallic, which is used to contain or shape molten weld metal. See backing.

seal weld — any weld designed primarily to provide a specific degree of tightness against leakage

seam weld — a continuous weld made between or upon overlapping members in which coalescence may start and occur on the faying surfaces, or may have proceeded from the surface of one member. The continuous weld may consist of a single weld bead or a series of overlapping spot welds. See resistance welding.

short-circuiting transfer (gas metal-arc welding) — metal transfer in which molten metal from a consumable electrode is deposited during repeated short circuits. See also globular transfer and spray transfer.

single-welded joint — a joint welded from one side only

single-welded lap joint — a lap joint in which the overlapped edges of the members to be joined are welded along the edge of one member only

slag inclusion — nonmetallic solid material entrapped in weld metal or between weld metal and base metal

specimen — refer to test specimen

spot weld — a weld made between or upon overlapping members in which coalescence may start and occur on

the faying surfaces or may proceed from the outer surface of one member. The weld cross section (plan view) is approximately circular.

spray-fuse — a thermal spraying technique in which the deposit is reheated to fuse the particles and form a metallurgical bond with the substrate

spray transfer (arc welding) — metal transfer in which molten metal from a consumable electrode is propelled axially across the arc in small droplets

stringer bead — a weld bead formed without appreciable weaving

surfacing — the application by welding, brazing, or thermal spraying of a layer(s) of material to a surface to obtain desired properties or dimensions, as opposed to making a joint

tee joint (T) — a joint between two members located approximately at right angles to each other in the form of a T

test coupon — a weld or braze assembly for procedure or performance qualification testing. The coupon may be any product from plate, pipe, tube, etc., and may be a fillet weld, overlay, deposited weld metal, etc.

test specimen — a sample of a test coupon for specific test. The specimen may be a bend test, tension test, impact test, chemical analysis, macrotest, etc. A specimen may be a complete test coupon, for example, in radiographic testing or small diameter pipe tension testing.

thermal cutting (TC) — a group of cutting processes that severs or removes metal by localized melting, burning, or vaporizing of the workpieces

throat, actual (of fillet) — the shortest distance from the root of a fillet weld to its face

throat, effective (of fillet) — the minimum distance from the fillet face, minus any convexity, to the weld root. In the case of fillet welds combined with a groove weld, the weld root of the groove weld shall be used.

throat, theoretical (of fillet) — the distance from the beginning of the joint root perpendicular to the hypotenuse of the largest right triangle that can be inscribed within the cross-section of a fillet weld. This dimension is based on the assumption that the root opening is equal to zero.

undercut — a groove melted into the base metal adjacent to the weld toe or weld root and left unfilled by weld metal

upper transformation temperature — the temperature at which transformation of the ferrite to austenite is completed during heating

usability — a measure of the relative ease of application of a filler metal to make a sound weld or braze joint

weave bead — a weld bead formed using weaving

weaving — a welding technique in which the energy source is oscillated transversely as it progresses along the weld path

weld — a localized coalescence of metals or nonmetals produced either by heating the materials to the welding temperature, with or without the application of pressure, or by the application of pressure alone and with or without the use of filler material

weld, autogenous — a fusion weld made without filler metal

weld bead — a weld deposit resulting from a pass. See stringer bead and weave bead.

weld face — the exposed surface of a weld on the side from which welding was done

weld interface — the interface between the weld metal and base metal in a fusion weld

weld metal — metal in a fusion weld consisting of that portion of the base metal and filler metal melted during welding

weld reinforcement — weld metal on the face or root of a groove weld in excess of the metal necessary for the specified weld size

weld size: groove welds — the depth of chamfering plus any penetration beyond the chamfering, resulting in the strength carrying dimension of the weld

weld size: for equal leg fillet welds — the leg lengths of the largest isosceles right triangle which can be inscribed within the fillet weld cross section

weld size: for unequal leg fillet welds — the leg lengths of the largest right triangle which can be inscribed within the fillet weld cross section

welder — one who performs manual or semiautomatic welding

welding, arc stud (SW) — an arc welding process that uses an arc between a metal stud, or similar part, and the other workpiece. The process is used without filler metal, with or without shielding gas or flux, with or without partial shielding from a ceramic or graphite ferrule surrounding the stud, and with the application of pressure after the faying surfaces are sufficiently heated.

welding, automatic — welding with equipment which performs the welding operation without adjustment of the controls by a welding operator. The equipment may or may not perform the loading and unloading of the work. See machine welding.

welding, consumable guide electroslag — an electroslag welding process variation in which filler metal is supplied by an electrode and its guiding member

welding, electrogas (EGW) — an arc welding process that uses an arc between a continuous filler metal electrode and the weld pool, employing approximately vertical welding progression with retainers to confine the weld metal. The process is used with or without an externally supplied shielding gas and without the application of pressure. Shielding for use with solid or metal-cored electrodes is obtained from a gas or gas mixture. Shielding for use with flux-cored electrodes may or may not be obtained from an externally supplied gas or gas mixture.

welding, electron beam (EBW) — a welding process that produces coalescence with a concentrated beam composed primarily of high velocity electrons, impinging on the joint. The process is used without shielding gas and without the application of pressure.

welding, electroslag (ESW) — a welding process producing coalescence of metals with molten slag which melts the filler metal and the surfaces of the work to be welded. The molten weld pool is shielded by this slag which moves along the full cross section of the joint as welding progresses. The process is initiated by an arc which heats the slag. The arc is then extinguished and the conductive slag is maintained in a molten condition by its resistance to electric current passing between the electrode and the work. See electroslag welding electrode and consumable guide electroslag welding.

welding, flux-cored arc (FCAW) — a gas metal-arc welding process that uses an arc between a continuous filler metal electrode and the weld pool. The process is used with shielding gas from a flux contained within the tubular electrode, with or without additional shielding from an externally supplied gas, and without the application of pressure.

welding, friction (FRW) — a solid state welding process that produces a weld under compressive force contact of workpieces rotating or moving relative to one another to produce heat and plastically displace material from the faying surfaces

welding, friction, inertia and continuous drive — processes and types of friction welding (solid state welding process) wherein coalescence is produced after heating is obtained from mechanically induced sliding motion between rubbing surfaces held together under pressure. Inertia welding utilizes all of the kinetic energy stored in a revolving flywheel spindle system. Continuous drive friction welding utilizes the energy provided by a continuous drive source such as an electric or hydraulic motor.

welding, gas metal-arc (GMAW) — an arc welding process that uses an arc between a continuous filler metal electrode and the weld pool. The process is used with shielding from an externally supplied gas and without the application of pressure.

welding, gas metal-arc, pulsed arc (GMAW-P) — a variation of the gas metal-arc welding process in which the current is pulsed. See also pulsed power welding.

welding, gas metal-arc, short-circuiting arc (GMAW-S) — a variation of the gas metal-arc welding process in which the consumable electrode is deposited during repeated short circuits. See also short-circuiting transfer.

welding, gas tungsten-arc (GTAW) — an arc welding process which produces coalescence of metals by heating them with an arc between a tungsten (nonconsumable) electrode and the work. Shielding is obtained from a gas or gas mixture. Pressure may or may not be used and filler metal may or may not be used. (This process has sometimes been called TIG welding, a nonpreferred term.)

welding, gas tungsten-arc, pulsed arc (GTAW-P) — a variation of the gas tungsten-arc welding process in which the current is pulsed. See also pulsed power welding.

welding, induction (IW) — a welding process that produces coalescence of metals by the heat obtained from resistance of the workpieces to the flow of induced high frequency welding current with or without the application of pressure. The effect of the high-frequency welding current is to concentrate the welding heat at the desired location.

welding, laser beam (LBW) — a welding process which produces coalescence of materials with the heat obtained from the application of a concentrated coherent light beam impinging upon the members to be joined

welding, machine — welding with equipment which performs the welding operation under the constant observation and control of a welding operator. The equipment may or may not perform the loading and unloading of the work. See automatic welding.

welding, manual — welding wherein the entire welding operation is performed and controlled by hand

welding, operator — one who operates machine or automatic welding equipment

welding, oxyfuel gas (OFW) — a group of welding processes which produces coalescence by heating materials with an oxyfuel gas flame or flames, with or without the application of pressure, and with or without the use of filler metal

welding, plasma-arc (PAW) — an arc welding process which produces coalescence of metals by heating them with a constricted arc between an electrode and the workpiece (transferred arc), or the electrode and the constricting nozzle (nontransferred arc). Shielding is obtained from the hot, ionized gas issuing from the torch orifice which may be supplemented by an auxiliary source of shielding gas. Shielding gas may be an inert gas or a mixture of gases. Pressure may or may not be used, and filler metal may or may not be supplied.

welding, projection (PW) — a resistance welding process that produces coalescence by the heat obtained from the resistance of the flow of welding current. The resulting welds are localized at predetermined points by projections, embossments, or intersections. The metals to be joined lap over each other.

welding, resistance (RW) — a group of welding processes that produces coalescence of the faying surfaces with the heat obtained from resistance of the workpieces to the flow of the welding current in a circuit of which the workpieces are a part, and by the application of pressure

welding, resistance seam (RSEW) — a resistance welding process that produces a weld at the faying surfaces of overlapped parts progressively along a length of a joint. The weld may be made with overlapping weld nuggets, a continuous weld nugget, or by forging the joint as it is heated to the welding temperature by resistance to the flow of the welding current.

welding, resistance spot (RSW) — a resistance welding process that produces a weld at the faying surfaces of a joint by the heat obtained from resistance to the flow of welding current through the workpieces from electrodes that serve to concentrate the welding current and pressure at the weld area

welding, resistance stud — a resistance welding process wherein coalescence is produced by the heat obtained from resistance to electric current at the interface between the stud and the workpiece, until the surfaces to be joined are properly heated, when they are brought together under pressure

welding, semiautomatic arc — arc welding with equipment which controls only the filler metal feed. The advance of the welding is manually controlled.

welding, shielded metal-arc (SMAW) — an arc welding process with an arc between a covered electrode and the weld pool. The process is used with shielding from the decomposition of the electrode covering, without the application of pressure, and with filler metal from the electrode

welding, stud — a general term for the joining of a metal stud or similar part to a workpiece. Welding may be accomplished by arc, resistance, friction, or other suitable process with or without external gas shielding.

welding, submerged-arc (SAW) — an arc welding process that uses an arc or arcs between a bare metal electrode or electrodes and the weld pool. The arc and molten metal are shielded by a blanket of granular flux on the workpieces. The process is used without pressure and with filler metal from the electrode and sometimes from a supplemental source (welding rod, flux, or metal granules).

weldment — an assembly whose constituent parts are joined by welding, or parts which contain weld metal overlay

ARTICLE V
STANDARD WELDING PROCEDURE SPECIFICATIONS (SWPSs)

A00

QW-500 GENERAL

The SWPSs listed in Appendix E are acceptable for construction in which the requirements of the ASME Boiler and Pressure Vessel Code, Section IX are specified. Any requirements of the applicable Construction Code Section regarding SWPS take precedence over the requirements of Section IX. These SWPSs are not permitted for construction where impact testing of the WPS is required by the Construction Code.

QW-510 ADOPTION OF SWPSs

Prior to use, the manufacturer or contractor that will be responsible for and provide operational control over production welding shall comply with the following for each SWPS that it intends to use, except as noted in QW-520.

(a) Enter the name of the manufacturer or contractor on the SWPS.

(b) An employee of that manufacturer or contractor shall sign and date the SWPS.

(c) The applicable Code Section(s) (Section VIII, B31.1, etc.) and/or any other fabrication document (contract, specification, etc.) that must be followed during welding shall be listed on the SWPS.

(d) The manufacturer or contractor shall weld and test one groove weld test coupon following that SWPS. The following information shall be recorded:

(1) the specification, type, and grade of the base metal welded;

(2) groove design;

(3) initial cleaning method;

(4) presence or absence of backing;

(5) The ASME or AWS specification and AWS classification of electrode or filler metal used and manufacturer's trade name;

(6) size and classification of tungsten electrode for GTAW;

(7) size of consumable electrode or filler metal;

(8) shielding gas and flow rate for GTAW and GMAW;

(9) preheat temperature;

(10) position of the groove weld and, if applicable, the progression;

(11) if more than one process or electrode type is used, the approximate weld metal deposit thickness for each process or electrode type;

(12) maximum interpass temperature;

(13) post weld heat treatment used, including holding time and temperature range;

(14) visual inspection and mechanical testing results;

(15) the results of radiographic examination when permitted as an alternative to mechanical testing by QW-304.

(e) The coupon shall be visually examined in accordance with QW-302.4 and mechanically tested in accordance with QW-302.1 or radiographically examined in accordance with QW-302.2. If visual examination, radiographic examination, or any test specimen fails to meet the required acceptance criteria, the test coupon shall be considered as failed and a new test coupon shall be welded before the organization may use the SWPS.

QW-511 Use of Demonstrated SWPSs

Code Sections or fabrication documents that are required to be referenced by QW-510(c) may be added or deleted from a demonstrated SWPS without further demonstrations.

QW-520 USE OF SWPSs WITHOUT DISCRETE DEMONSTRATION

Once an SWPS has been demonstrated, additional SWPSs that are similar to the SWPS that was demonstrated may be used without further demonstration. Such additional SWPSs shall be compared to the SWPS that was used for the demonstration, and the following limitations shall not be exceeded:

(a) a change in the welding process. When a single-process SWPS has been demonstrated, multi-process SWPSs may be followed, but only the process that was demonstrated may be used.

(b) a change in the P- or S-Number;

(c) a change from the as-welded condition to the heat-treated condition. This limitation also applies for SWPSs that allow use in both conditions (e.g., SWPS B2.1-021 allows production welding with or without heat treatment; if the demonstration was performed without heat treatment, production welding with heat treatment is not permitted). Once heat treatment has been demonstrated for any SWPS, this limitation no longer applies.

(d) a change from a gas-shielded flux-cored wire or solid wire to a self-shielded flux-cored wire or vice versa;

(e) a change from spray, globular, or pulsed transfer mode to short-circuiting transfer mode or vice-versa;

(f) a change in the F-Number of the welding electrode;

(g) the addition of preheat above ambient temperature;

(h) a change from an SWPS that is identified as for sheet metal to one that is not and vice versa.

QW-530 FORMS

A suggested Form QW-485 for documenting the welding conditions and test results of the demonstration is provided in Nonmandatory Appendix B.

QW-540 PRODUCTION USE OF SWPSs

As with any WPS, welding that is done following an SWPS shall be done in strict accordance with the SWPS. In addition, the following conditions apply to the use of SWPSs:

(a) The manufacturer or contractor may not deviate from the welding conditions specified on the SWPS.

(b) SWPSs may not be supplemented with PQRs or revised in any manner except for reference to the applicable Code Section or other fabrication documents as provided by QW-511.

(c) Only the welding processes shown on an SWPS shall be used in given production joint. When a multi-process SWPS is selected, the processes shown on the SWPS shall be used in the order and manner specified on the SWPS.

(d) SWPSs shall not be used in the same production joint together with WPSs qualified by the manufacturer or contractor.

(e) The manufacturer or contractor may supplement an SWPS by attaching additional instructions to provide the welder with further direction for making production welds to Code or other requirements. When SWPSs are supplemented with instructions that address any condition shown on the SWPS, such instructions shall be within the limits of the SWPS. For example, when an SWPS permits use of several electrode sizes, supplemental instructions may direct the welder to use only one electrode size out of those permitted by the SWPS; however, the supplemental instructions may not permit the welder to use a size other than one or more of those permitted by the SWPS.

(f) SWPSs may not be used until the demonstration of QW-510 has been satisfactorily welded, tested, and certified.

(g) The identification number of the Supporting Demonstration shall be noted on each SWPS that it supports prior to using the SWPS.

(h) The certified Supporting Demonstration Record shall be available for review by Authorized Inspector.

PART QB BRAZING

ARTICLE XI
BRAZING GENERAL REQUIREMENTS

QB-100 GENERAL

Section IX of the ASME Boiler and Pressure Vessel Code relates to the qualification of welders, welding operators, brazers, and brazing operators, and the procedures that they employ in welding and brazing according to the ASME Boiler and Pressure Vessel Code and the ASME B31 Code for Pressure Piping. It is divided into two parts: Part QW gives requirements for welding and Part QB contains requirements for brazing.

QB-100.1 The purpose of the Brazing Procedure Specification (BPS) and Procedure Qualification Record (PQR) is to determine that the brazement proposed for construction is capable of providing the required properties for its intended application. It is presupposed that the brazer or brazing operator performing the brazing procedure qualification test is a skilled workman. That is, the brazing procedure qualification test establishes the properties of the brazement, not the skill of the brazer or brazing operator. Briefly, a BPS lists the variables, both essential and nonessential, and the acceptable ranges of these variables when using the BPS. The BPS is intended to provide direction for the brazer or brazing operator. The PQR lists what was used in qualifying the BPS and the test results.

QB-100.2 In performance qualification, the basic criterion established for brazer qualification is to determine the brazer's ability to make a sound brazed joint. The purpose of the performance qualification test for the brazing operator is to determine the operator's mechanical ability to operate the brazing equipment.

QB-100.3 Brazing Procedure Specifications (BPS) written and qualified in accordance with the rules of this Section, and brazers and operators of automatic and machine brazing equipment also qualified in accordance with these rules may be used in any construction built to the requirements of the ASME Boiler and Pressure Vessel Code or the ASME B31 Code for Pressure Piping.

However, other Sections of the Code state the conditions under which Section IX requirements are mandatory, in whole or in part, and give additional requirements. The reader is advised to take these provisions into consideration when using this Section.

Brazing Procedure Specifications, Procedure Qualification Records, and Brazer or Brazing Operator Performance Qualifications made in accordance with the requirements of the 1962 Edition or any later Edition of Section IX may be used in any construction built to the ASME Boiler and Pressure Vessel Code or the ASME B31 Code for Pressure Piping.

Brazing Procedure Specifications, Procedure Qualification Records, and Brazer or Brazing Operator Performance Qualifications made in accordance with the requirements of the Editions of Section IX prior to 1962, in which all of the requirements of the 1962 Edition or later Editions are met, may also be used.

Brazing Procedure Specifications and Brazer/Brazing Operator Performance Qualification Records meeting the above requirements do not need to be amended to include any variables required by later Editions and Addenda.

Qualification of new Brazing Procedure Specifications or Brazers/Brazing Operators and requalification of existing Brazing Procedure Specifications or Brazers/Brazing Operators shall be in accordance with the current Edition (see Foreword) and Addenda of Section IX.

QB-101 Scope

The rules in this Section apply to the preparation of Brazing Procedure Specifications, and the qual-

ification of brazing procedures, brazers, and brazing operators for all types of manual and machine brazing processes permitted in this Section. These rules may also be applied, insofar as they are applicable, to other manual or machine brazing processes, permitted in other Sections.

A00 **QB-102 Terms and Definitions**

Some of the more common terms relating to brazing are defined in QW/QB-492. These are in substantial agreement with the definitions of the American Welding Society given in its document, A3.0-89, Standard Welding Terms and Definitions.

Wherever the word pipe is designated, tubes shall also be applicable.

QB-103 Responsibility

QB-103.1 Brazing. Each manufacturer[1] or contractor[1] is responsible for the brazing done by his organization, and shall conduct the tests required in this Section to qualify the brazing procedures he uses in the construction of the brazed assemblies built under this Code and the performance of brazers and brazing operators who apply these procedures.

QB-103.2 Records. Each manufacturer or contractor shall maintain a record of the results obtained in brazing procedure and brazer or brazing operator performance qualifications. These records shall be certified by the manufacturer or contractor and shall be accessible to the Authorized Inspector. Refer to recommended Forms in Nonmandatory Appendix B.

QB-110 BRAZE ORIENTATION

The orientations of brazes with respect to planes of reference are classified in accordance with QB-461 into four positions[2] (A, B, C, and D in column 1), based on the basic flow of brazing filler metal through joints. These positions are flat flow, vertical downflow, vertical upflow, and horizontal flow.

[1] Wherever these words are used in Section IX, they shall include installer or assembler.

[2] In the following paragraphs the word *position* is synonymous with *flow position.*

QB-120 TEST POSITIONS FOR LAP, BUTT, SCARF, OR RABBET JOINTS

Brazed joints may be made in test coupons oriented in any of the positions in QB-461 and as described in the following paragraphs, except that angular deviation from the specified horizontal and vertical flow planes in accordance with column 1 of QB-461 is permitted during brazing.

QB-121 Flat-Flow Position

The joints in position suitable for applying brazing filler metal in rod, strip, or other suitable form under the flat-flow conditions are shown in sketches (1) through (5) of Line A in QB-461. The maximum permitted angular deviation from the specified flow plane is ± 15 deg.

QB-122 Vertical-Downflow Position

The joints in a position suitable for applying brazing filler metal in rod, strip, or other suitable form under the vertical-downflow conditions are shown in sketches (1) through (4) of Line B in QB-461. The brazing filler metal flows by capillary action with the aid of gravity downward into the joint. The maximum permitted angular deviation from the specified flow plane is ± 75 deg.

QB-123 Vertical-Upflow Position

The joints in position suitable for applying brazing filler metal in rod, strip, or other suitable form under the vertical-upflow conditions are shown in sketches (1) through (4) of Line C in QB-461. The brazing filler metal flows by capillary action through the joint. The maximum permitted angular deviation from the specified flow plane is ± 75 deg.

QB-124 Horizontal-Flow Position

The joints in a position suitable for applying brazing filler metal in rod, strip, or other suitable form under the horizontal-flow conditions are shown in sketches (1) and (2) of Line D of QB-461. The brazing filler metal flows horizontally by capillary action through the joint. The maximum permitted angular deviation from the specified flow plane is ± 75 deg.

surface bend specimens shall conform to the dimensions given in QB-462.2(b).

QB-161.6 Longitudinal Second Surface Bend. The joint is parallel to the longitudinal axis of the specimen, which is bent so that the second surface becomes the convex surface of the specimen. The definition of the second surface is given in QB-161.2. Longitudinal second surface bend specimens shall conform to the dimensions given in QB-462.2(b).

QB-162 Guided-Bend Test Procedure

QB-162.1 Jigs. Guided-bend specimens shall be bent in test jigs that are in substantial accordance with QB-466. When using the jigs in accordance with QB-466.1 or QB-466.2, the side of the specimen turned toward the gap of the jig shall be the first surface for first surface bend specimens (defined in QB-161.1), and the second surface for second surface bend specimens (defined in QB-161.2). The specimen shall be forced into the die by applying load on the plunger until the curvature of the specimen is such that a $\frac{1}{8}$ in. (3.2 mm) diameter wire cannot be inserted between the specimen and the die of QB-466.1, or the specimen is bottom ejected, if the roller type of jig (QB-466.2) is used.

When using the wrap around jig (QB-466.3) the side of the specimen turned toward the roller shall be the first surface for first surface bend specimens, and the second surface for second surface bend specimens.

A00 QB-163 Acceptance Criteria — Bend Tests

The joint of a transverse-bend specimen shall be completely within the bent portion of the specimen after testing.

The guided-bend specimens shall have no open discontinuities exceeding $\frac{1}{8}$ in. (3.2 mm), measured in any direction on the convex surface of the specimen after bending. Cracks occurring on the corners of the specimen during testing shall not be considered, unless there is definite evidence that they result from flux inclusions, voids, or other internal discontinuities.

QB-170 PEEL TESTS

QB-171 Specimens

The dimensions and preparation of the peel test specimen shall conform to the requirements of QB-462.3.

QB-172 Acceptance Criteria — Peel Test A00

In order to pass the peel test, the specimens shall show evidence of brazing filler metal along each edge of the joint. Specimens shall be separated or peeled either by clamping Section A and striking Section B with a suitable tool such that the bending occurs at the fulcrum point (see QB-462.3), or by clamping Section A and Section B in a machine suitable for separating the sections under tension. The separated faying surfaces of joints shall meet the following criteria.

(a) The total area of discontinuities (unbrazed areas, flux inclusions, etc.) shall not exceed 25% of the total area of any individual faying surface.

(b) The sum of the lengths of the discontinuities measured on any one line in the direction of the lap shall not exceed 25% of the lap.

(c) No discontinuity shall extend continuously from one edge of the joint to the other edge, irrespective of its direction.

QB-180 SECTIONING TESTS AND WORKMANSHIP COUPONS

QB-181 Sectioning Test Specimens

The dimensions and configuration of the sectioning test specimens shall conform to the requirements of QB-462.4. Each side of the specimen shall be polished and examined with at least a four-power magnifying glass. The sum of the length of unbrazed areas on either side, considered individually, shall not exceed 20% of the length of the joint overlap.

QB-182 Workmanship Coupons

The dimensions and configuration of the workmanship coupon shall conform to the nearest approximation of the actual application. Some typical workmanship coupons are shown in QB-462.5. Each side of the specimen shall be polished and examined with at least a four-power magnifying glass. The sum of the length of unbrazed areas on either side, considered individually, shall not exceed 20% of the length of the joint overlap.

QB-304 Brazers

Each brazer who brazes under the rules of this Code shall have passed the tests prescribed in QB-302 for performance qualifications.

A brazer qualified to braze in accordance with one qualified BPS is also qualified to braze in accordance with other qualified BPSs, using the same brazing process, within the limits of the essential variables of QB-350.

QB-305 Brazing Operators

The brazing operator who prepares brazing procedure qualification test specimens meeting requirements of QB-451 is thereby qualified. Alternatively, each brazing operator who brazes on vessels constructed under the rules of this Code shall be examined for each brazing procedure under which he does brazing by semiautomatic or automatic processes (such as the resistance, induction, or furnace processes) as follows.

(a) A typical joint or workmanship coupon embodying the requirements of a qualified brazing procedure shall be brazed and sectioned. Typical joints are shown in QB-462.5.

(b) In order to ensure that the operator can carry out the provisions of the brazing procedure, the test sections required in (a) shall meet the requirements of QB-452.

QB-310 QUALIFICATION TEST COUPONS

QB-310.1 Test Coupons. The test coupons may be plate, pipe, or other product forms. The dimensions of the test coupon and length of braze shall be sufficient to provide the required test specimens.

QB-310.2 Braze Joint. The dimensions of the braze joint at the test coupon used in making qualification tests shall be the same as those in the Brazing Procedure Specification (BPS).

QB-310.3 Base Metals. When a brazer or brazing operator is to be qualified, the test coupon shall be base metal of the P-Number or P-Numbers to be joined in production brazing.

QB-320 RETESTS AND RENEWAL OF QUALIFICATION

QB-321 Retests

A brazer or brazing operator who fails to meet the requirements for one or more of the test specimens prescribed in QB-452 may be retested under the following conditions.

QB-321.1 Immediate Retest. When an immediate retest is made, the brazer or brazing operator shall make two consecutive test coupons for each position which he has failed, all of which shall pass the test requirements.

QB-321.2 Further Training. When the brazer or brazing operator has had further training or practice, a complete retest shall be made for each position on which he failed to meet the requirements.

QB-322 Renewal of Qualification

Renewal of qualification of a performance qualification is required:

(a) when a brazer or brazing operator has not used the specific brazing process for a period of 6 months or more; or

(b) when there is a specific reason to question his ability to make brazes that meet the specification. Renewal of qualification for a specific brazing process under (a) may be made with specific brazing process by making only one test joint (plate or pipe) with all the essential variables used on any one of the brazer's or brazing operator's previous qualification test joints. This will reestablish the brazer's or brazing operator's qualification for all conditions for which he had previously qualified with the specific brazing process.

QB-350 BRAZING VARIABLES FOR BRAZERS AND BRAZING OPERATORS

QB-351 General A00

A brazer or brazing operator shall be requalified whenever a change is made in one or more of the essential variables for each brazing process, as follows:

(a) Torch Blazing (TB)
(b) Furnace Brazing (FB)
(c) Induction Brazing (IB)
(d) Resistance Brazing (RB)
(e) Dip Brazing (DB)

QB-351.1 Essential Variables — Manual, Semiautomatic, and Machine Brazing A00

QB-402 Base Metal
QB-402.2
QB-402.3

QB-403 Brazing Filler Metal
QB-403.1
QB-403.2

QB-407 Flow Position
QB-407.1

QB-408 Joint Design
QB-408.1
QB-408.3

QB-410 Technique
QB-410.5

QB-353 DELETED A00

QB-354 DELETED A00

QB-355 DELETED A00

A00 **QB-351.2 Essential Variables — Automatic**

(a) A change from automatic to machine brazing.

(b) A change in brazing process.

QB-356 DELETED A00

A00 QB-352 DELETED

QB-357 DELETED A00

QB-416 DELETED **A00**

QB-420 P-NUMBERS

(See Part QW, Welding — QW-420)

QB-430 F-NUMBERS

QB-431 General

The following F-Number grouping of brazing filler metals in QB-432 is based essentially on their usability characteristics, which fundamentally determine the ability of brazers and brazing operators to make satisfactory brazements with a given filler metal. This grouping is made to reduce the number of brazing procedure and performance qualifications, where this can logically be done. The grouping does not imply that filler metals within a group may be indiscriminately substituted for a filler metal which was used in the qualification test without consideration of the compatibility from the standpoint of metallurgical properties, design, mechanical properties, postbraze heat treatment, and service requirements.

QB-432
F-NUMBERS
Grouping of Brazing Filler Metals for Procedure and Performance Qualification SFA-5.8

QB	F-No.	AWS Classification No.
	101	BAg-1
432.1		BAg-1a
		BAg-8
		BAg-8a
		BAg-22
		BAg-23
		BVAg-0
		BVAg-8
		BVAg-8b
		BVAg-30
432.2	102	BAg-2
		BAg-2a
		BAg-3
		BAg-4
		BAg-5
		BAg-6
		BAg-7
		BAg-9
		BAg-10
		BAg-13
		BAg-13a
		BAg-18
		BAg-19
		BAg-20
		BAg-21
		BAg-24
		BAg-26
		BAg-27
		BAg-28
		BAg-33
		BAg-34
		BAg-35
		BAg-36
		BAg-37
		BVAg-6b
		BVAg-18
		BVAg-29
		BVAg-31
		BVAg-32

(QB-432 continues on next page)

APPENDIX B — NONMANDATORY WELDING AND BRAZING FORMS

B-100 FORMS

This Nonmandatory Appendix illustrates sample formats for Welding and Brazing Procedure Specifications, Procedure Qualification Records, and Performance Qualification.

A00

B-101 Welding

Form QW-482 is a suggested format for Welding Procedure Specifications (WPS); Form QW-483 is a suggested format for Procedure Qualification Records (PQR). These forms are for the shielded metal-arc (SMAW), submerged-arc (SAW), gas metal-arc (GMAW), and gas tungsten-arc (GTAW) welding processes, or a combination of these processes.

Forms for other welding processes may follow the general format of Forms QW-482 and QW-483, as applicable.

Form QW-484 is a suggested format for Welder/Welding Operator/Performance Qualification (WPQ) for groove or fillet welds.

Form QW-485 is a suggested format for Demonstration of Standard Welding Procedure Specifications.

B-102 Brazing

Form QB-482 is a suggested format for Brazing Procedure Specifications (BPS); Form QB-483 is a suggested format for Procedure Qualifications Records (PQR). These forms are for torch brazing (TB), furnace brazing (FB), induction brazing (IB, resistance brazing (RB), and dip brazing (DB) processes.

Forms for other welding processes may follow the general format of Forms QW-482 and QW-483, as applicable.

Form QB-484 is a suggested format for Brazer/Brazing Operator/Performance Qualification (BPQ).

A00

QW-482 SUGGESTED FORMAT FOR WELDING PROCEDURE SPECIFICATIONS (WPS)
(See QW-200.1, Section IX, ASME Boiler and Pressure Vessel Code)

Company Name _____ By: _____

Welding Procedure Specification No. _____ Date _____ Supporting PQR No.(s) _____

Revision No. _____ Date _____

Welding Process(es) _____ Type(s) _____
(Automatic, Manual, Machine, or Semi-Auto.)

JOINTS (QW-402) Details

Joint Design _____

Backing (Yes) _____ (No) _____

Backing Material (Type) _____
(Refer to both backing and retainers.)

☐ Metal ☐ Nonfusing Metal

☐ Nonmetallic ☐ Other

Sketches, Production Drawings, Weld Symbols or Written Description should show the general arrangement of the parts to be welded. Where applicable, the root spacing and the details of weld groove may be specified.

(At the option of the Mfgr., sketches may be attached to illustrate joint design, weld layers and bead sequence, e.g., for notch toughness procedures, for multiple process procedures, etc.)

*BASE METALS (QW-403)

P-No. _____ Group No. _____ to P-No. _____ Group No. _____

OR

Specification type and grade _____

to Specification type and grade _____

OR

Chem. Analysis and Mech. Prop. _____

to Chem. Analysis and Mech. Prop. _____

Thickness Range:

Base Metal: Groove _____ Fillet _____

Other _____

*FILLER METALS (QW-404)		
Spec. No. (SFA)		
AWS No. (Class)		
F-No.		
A-No.		
Size of Filler Metals		
Weld Metal		
Thickness Range:		
Groove		
Fillet		
Electrode-Flux (Class)		
Flux Trade Name		
Consumable Insert		
Other		

*Each base metal-filler metal combination should be recorded individually.

This form (E00006) may be obtained from the Order Dept., ASME, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300

SAMPLE

QW-485 SUGGESTED FORMAT FOR DEMONSTRATION OF STANDARD WELDING PROCEDURE SPECIFICATIONS (WPS)
(See Article V) **A00**

Identification of Standard Welding Procedure Specification Demonstrated: _____

Demonstration Welding Conditions

Specification, Type, and Grade of Base Metal(s): _____
To Specification, Type, and Grade of Base Metal(s): _____
Base Metal P- or S-Number _____ to Base Metal P- or S-Number _____ Thickness: _____

Welding Process(es) used: _____
☐ Plate ☐ Pipe (Enter Diameter of Pipe or Tube): _____
Groove Type (Single V, Double V, Single U, etc.): _____
Initial Cleaning Method: _____
Backing (Metal, Weld Metal, Backwelded, etc.): _____
Filler Metal (SFA) Specification: _____
Filler Metal or Electrode Classification: _____
Filler Metal or Electrode Trade Name: _____
Tungsten Electrode Type and Size for GTAW: _____
Consumable Insert Class and Size for GTAW or PAW: _____
Backing Gas Composition and Flow Rate for GTAW, PAW, GMAW: _____
Preheat Temperature (°F): _____
Position (F, V, OH, H) of Weld: _____
Progression (Uphill or Downhill): _____
Interpass Cleaning Method: _____
Measured Interpass Temperature (°F): _____
Approximate Deposit Thickness for Each Filler Metal or Electrode Type (in.): _____
Current Type/Polarity (AC, DCEP, DCEN): _____
Postweld Heat Treatment Time and Temperature: _____

Visual Examination of Completed Weld: _____ Date of Test: _____

Bend Test ☐ Transverse Root and Face [QW-462.3(a)] ☐ Side (QW-462.2)

Type	Result	Type	Result	Type	Result

Alternative Radiographic Examination Results: _____
Specimens Evaluated By: _____ Title: _____ Company: _____
Welding Supervised By: _____ Title: _____ Company: _____
Welder's Name: _____ Stamp No. _____
We certify that the statements in this record are correct and that the weld described above was prepared, welded, and tested in accordance with the requirements of Section IX of the ASME Code.
Manufacturer or Contractor: _____
By: _____ Date: _____ Demonstration Number: _____

This form (E00136) may be obtained from the Order Dept., ASME, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300.

SAMPLE

A00

QB-482 SUGGESTED FORMAT FOR BRAZING PROCEDURE SPECIFICATIONS (BPS)
(See QB-200.1, Section IX, ASME Boiler and Pressure Vessel Code)

Company Name _____

BPS No. _____ Date _____ Supporting PQR No. _____

Revisions _____ _____ _____

_____ _____ _____

Brazing Process(es) _____ Type(s) _____
(Manual, mechanical torch, etc.)

JOINTS (QB-408)
Type of Joint(s) _____
Joint Clearance Range _____
Lap Length Range _____
Sketches, production drawings, symbols, or written description should show the general arrangement of the parts to be joined.
(At the option of the Mfgr., sketches may be attached to illustrate joint design.)

SAMPLE

BASE METALS (QB-402)
P-No. _____ to P-No. _____
Spec. type and grade _____
to spec. type and grade _____
OR
Chem. analysis and mech. prop _____
to chem. analysis and mech. prop. _____
Thickness Range _____
Other _____

FILLER METALS (QB-403)
F-No. _____ Other _____
ASME Spec. No. _____ Other _____
AWS Class No. _____ Other _____
Size or Shape of Filler Metal _____
Other _____

BRAZING TEMPERATURE (QB-404)
Temperature Range* _____
Other _____
*Not applicable for torch brazing

BRAZING FLUX OR ATMOSPHERE (QB-406)
Flux Trade Name or Composition _____
Atmosphere for Furnace Brazing _____
_____ [name or trade designation of the fuel used or the name or trade designation of the gas compressing the atmosphere (hydrogen, Ammo-Gas, etc.) and a statement regarding the designed character of the furnace atmosphere, e.g., whether it is reducing, decarburizing, inert, etc.]

FLOW POSITION (QB-407)
Flow Position(s) _____
Method of Applying Filler (Metal _____
_____ (face feeding, preplaced rings, shims, spray deposit, cladding, etc.)
Other _____

POSTBRAZE HEAT TREATMENT (QB-409)
Type and temperature of aging or stabilizing thermal treatment after brazing _____
_____
_____

TECHNIQUE (QB-410)
Method of Precleaning _____
Method of Postbrazing Cleaning _____
Type of Flame _____
Torch Tip Size _____
Other _____

This form (E00031) may be obtained from the Order Dept., ASME, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300.

QB-483 SUGGESTED FORMAT FOR PROCEDURE QUALIFICATION RECORDS (PQR)
(See QB-200.2, Section IX, ASME Boiler and Pressure Vessel Code)
Record of Actual Conditions Used to Braze Test Coupon

Company Name _____

PQR No. _____ Date _____

BPS No. _____

Brazing Process(es) _____ Type(s) _____ (Manual, mechanical torch, etc.)

JOINTS (QB-408)
Type of Joint(s) _____
Joint Clearance _____
Length of Overlap _____
Other _____

Joint Design of Test Coupon

BASE METAL (QB-402)
P-No. _____ to P-No. _____
Material Spec. _____
Type or Grade _____
Thickness of Test Coupon _____
Method of Precleaning _____
Other _____

FILLER METALS (QB-403)
F-No. _____ Other _____
ASME Spec. No. _____ Other _____
AWS Class No. _____ Other _____
Size or Shape of Filler Metal _____
Other _____

BRAZING TEMPERATURE (QB-404)
Temperature Range* _____
Other _____
*Not applicable for torch brazing

BRAZING FLUX OR ATMOSPHERE (QB-406)
Flux Trade Name or Composition _____
Atmosphere for Furnace Brazing _____
_____ [name or trade designation of the fuel used or the name or trade designation of the gas compressing the atmosphere (hydrogen, dissociated ammonia, etc.) and a statement regarding the designed character of the furnace atmosphere, e.g., whether it is reducing, decarburizing, inert, etc.]

FLOW POSITION (QB-407)
Flow Position(s) _____
Method of Applying Filler Metal _____
_____ (face feeding, preplaced rings, shims, spray deposit, cladding, etc.)
Other _____

POSTBRAZE HEAT TREATMENT (QB-409)
Type and temperature of aging or stabilizing thermal treatment after brazing _____

TECHNIQUE (QB-410)
Method of Postbrazing Cleaning _____
Type of Flame _____
Torch Tip Size _____
Other _____

SAMPLE

This form (E00032) may be obtained from the Order Dept., ASME, 22 Law Drive, Box 2300, Fairfield, NJ 07007-2300

APPENDIX D — NONMANDATORY P-NUMBER LISTING (CONT'D)

P-No.	Grp. No.	Spec. No.	Type, Grade, or UNS No.
Steel and Steel Alloys (Cont'd)			
8	1	SA-403	WP304LN
8	1	SA-403	WP304N
8	1	SA-403	WP316
8	1	SA-403	WP316H
8	1	SA-403	WP316L
8	1	SA-403	WP316LN
8	1	SA-403	WP316N
8	1	SA-403	WP317
8	1	SA-403	WP317L
8	1	SA-403	WP321
8	1	SA-403	WP321H
8	1	SA-403	WP347
8	1	SA-403	WP347H
8	1	SA-403	WP348
8	1	SA-403	WP348H
8	1	SA-409	TP304
8	1	SA-409	TP304L
8	1	SA-409	TP316
8	1	SA-409	TP316L
8	1	SA-409	TP317
8	1	SA-409	TP321
8	1	SA-409	TP347
8	1	SA-409	TP348
8	1	SA-430	FP304
8	1	SA-430	FP304H
8	1	SA-430	FP304N
8	1	SA-430	FP316
8	1	SA-430	FP316H
8	1	SA-430	FP316N
8	1	SA-430	FP321
8	1	SA-430	FP321H
8	1	SA-430	FP347
8	1	SA-430	FP347H
8	1	SA-430	FP16-8-2H
8	1	SA-451	CPF3
8	1	SA-451	CPF3A
8	1	SA-451	CPF3M
8	1	SA-451	CPF8
8	1	SA-451	CPF8A
8	1	SA-451	CPF8C
8	1	SA-451	CPF8M
8	1	SA-452	TP304H
8	1	SA-452	TP316H
8	1	SA-452	TP347H
8	1	SA-479	302
8	1	SA-479	304
8	1	SA-479	304H
8	1	SA-479	304L
8	1	SA-479	304LN
8	1	SA-479	304N
8	1	SA-479	316
8	1	SA-479	316Cb
8	1	SA-479	316H
8	1	SA-479	316L
8	1	SA-479	316LN
8	1	SA-479	316N
8	1	SA-479	316Ti
8	1	SA-479	321
8	1	SA-479	321H
8	1	SA-479	347
8	1	SA-479	347H
8	1	SA-479	348
8	1	SA-479	348H
8	1	SA-479	S30600
8	1	SA-666	302
8	1	SA-666	304
8	1	SA-666	304L
8	1	SA-666	304LN
8	1	SA-666	304N
8	1	SA-666	316
8	1	SA-666	316L
8	1	SA-666	316N
8	1	SA-688	TP304
8	1	SA-688	TP304L
8	1	SA-688	TP304LN
8	1	SA-688	TP304N
8	1	SA-688	TP316
8	1	SA-688	TP316L
8	1	SA-688	TP316LN
8	1	SA-688	TP316N
8	1	SA-813	TP304
8	1	SA-813	TP304H
8	1	SA-813	TP304L
8	1	SA-813	TP304LN
8	1	SA-813	TP304N
8	1	SA-813	TP316
8	1	SA-813	TP316H
8	1	SA-813	TP316L
8	1	SA-813	TP316LN
8	1	SA-813	TP316N
8	1	SA-813	TP317
8	1	SA-813	TP317L

A00 APPENDIX D — NONMANDATORY P-NUMBER LISTING (CONT'D)

P-No.	Grp. No.	Spec. No.	Type, Grade, or UNS No.
Steel and Steel Alloys (Cont'd)			
8	1	SA-813	TP321
8	1	SA-813	TP321H
8	1	SA-813	TP347
8	1	SA-813	TP347H
8	1	SA-813	TP348
8	1	SA-813	TP348H
8	1	SA-813	TPXM-15
8	1	SA-814	TP304
8	1	SA-814	TP304H
8	1	SA-814	TP304L
8	1	SA-814	TP304LN
8	1	SA-814	TP304N
8	1	SA-814	TP316
8	1	SA-814	TP316H
8	1	SA-814	TP316L
8	1	SA-814	TP316LN
8	1	SA-814	TP316N
8	1	SA-814	TP317
8	1	SA-814	TP317L
8	1	SA-814	TP321
8	1	SA-814	TP321H
8	1	SA-814	TP347
8	1	SA-814	TP347H
8	1	SA-814	TP348
8	1	SA-814	TP348H
8	1	SA-814	TPXM-15
8	2	SA-182	F10
8	2	SA-182	F45
8	2	SA-182	F310
8	2	SA-213	S30815
8	2	SA-213	TP309Cb
8	2	SA-213	TP309H
8	2	SA-213	TP309S
8	2	SA-213	TP310Cb
8	2	SA-213	TP310S
8	2	SA-213	TP309HCb
8	2	SA-213	TP310H
8	2	SA-213	TP310MoLN
8	2	SA-213	TP310HCb
8	2	SA-240	S30815
8	2	SA-240	Type 309Cb
8	2	SA-240	Type 309H
8	2	SA-240	Type 309HCb
8	2	SA-240	Type 309S
8	2	SA-240	Type 310Cb
8	2	SA-240	Type 310HCb
8	2	SA-240	Type 310MoLN
8	2	SA-240	Type 310S
8	2	SA-249	S30815
8	2	SA-249	TP309Cb
8	2	SA-249	TP309H
8	2	SA-249	TP309HCb
8	2	SA-249	TP309S
8	2	SA-249	TP310Cb
8	2	SA-249	TP310H
8	2	SA-249	TP310S
8	2	SA-249	TP310MoLN
8	2	SA-312	S30815
8	2	SA-312	TP309Cb
8	2	SA-312	TP309H
8	2	SA-312	TP309HCb
8	2	SA-312	TP309S
8	2	SA-312	TP310Cb
8	2	SA-312	TP310H
8	2	SA-312	TP310HCb
8	2	SA-312	TP310S
8	2	SA-312	TP310MoLN
8	2	SA-336	F310
8	2	SA-351	CH8
8	2	SA-351	CH20
8	2	SA-351	CK20
8	2	SA-358	309
8	2	SA-358	309Cb
8	2	SA-358	309S
8	2	SA-358	310Cb
8	2	SA-358	310S
8	2	SA-358	S30815
8	2	SA-403	WP309
8	2	SA-403	WP310
8	2	SA-409	S30815
8	2	SA-409	TP309Cb
8	2	SA-409	TP309S
8	2	SA-409	TP310Cb
8	2	SA-409	TP310S
8	2	SA-451	CPH8
8	2	SA-451	CPH20
8	2	SA-451	CPK20
8	2	SA-479	309Cb
8	2	SA-479	309S
8	2	SA-479	310Cb
8	2	SA-479	310S
8	2	SA-479	S30815

APPENDIX D — NONMANDATORY P-NUMBER LISTING (CONT'D)

A99
A00

P-No.	Grp. No.	Spec. No.	Type, Grade, or UNS No.
Copper and Copper-Base Alloys (Cont'd)			
35		SB-171	C63000
35		SB-271	C95200
35		SB-271	C95400
35		SB-359	C60800
35		SB-395	C60800
35		SB-505	C95200
Nickel and Nickel-Base Alloys			
41		SB-160	N02200
41		SB-160	N02201
41		SB-161	N02200
41		SB-161	N02201
41		SB-162	N02200
41		SB-162	N02201
41		SB-163	N02200
41		SB-163	N02201
41		SB-366	N02200
41		SB-366	N02201
42		SB-127	N04400
42		SB-163	N04400
42		SB-164	N04400
42		SB-164	N04405
42		SB-165	N04400
42		SB-366	N04400
42		SB-564	N04400
43		SB-163	N06600
43		SB-163	N06690
43		SB-166	N06600
43		SB-166	N06690
43		SB-167	N06600
43		SB-167	N06690
43		SB-168	N06600
43		SB-168	N06690
43		SB-366	N06002
43		SB-366	N06600
43		SB-366	N06625
43		SB-435	N06002
43		SB-443	N06625
43		SB-444	N06625
43		SB-446	N06625
43		SB-516	N06600
43		SB-517	N06600
43		SB-564	N06600
43		SB-564	N06625
43		SB-564	N06690
43		SB-572	N06002
43		SB-619	N06002

P-No.	Grp. No.	Spec. No.	Type, Grade, or UNS No.
Nickel and Nickel-Base Alloys (Cont'd)			
43		SB-622	N06002
43		SB-626	N06002
43		SB-704	N06625
43		SB-705	N06625
44		SB-333	N10001
44		SB-333	N10665
44		SB-333	N10675
44		SB-335	N10001
44		SB-335	N10665
44		SB-335	N10675
44		SB-366	N06022
44		SB-366	N06059
44		SB-366	N06645
44		SB-366	N10001
44		SB-366	N10003
44		SB-366	N10276
44		SB-366	N10665
44		SB-366	N10675
44		SB-434	N10003
44		SA-494	N26022
44		SB-564	N06022
44		SB-564	N06059
44		SB-564	N10276
44		SB-564	N10675
44		SB-573	N10003
44		SB-574	N06022
44		SB-574	N06059
44		SB-574	N06455
44		SB-574	N10276
44		SB-575	N06022
44		SB-575	N06059
44		SB-575	N06455
44		SB-575	N10276
44		SB-619	N06022
44		SB-619	N06059
44		SB-619	N06455
44		SB-619	N10001
44		SB-619	N10276
44		SB-619	N10665
44		SB-619	N10675
44		SB-622	N06022
44		SB-622	N06059
44		SB-622	N06455
44		SB-622	N10001
44		SB-622	N10276
44		SB-622	N10665
44		SB-622	N10675
44		SB-626	N06022
44		SB-626	N06059

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APPENDIX D — NONMANDATORY P-NUMBER LISTING (CONT'D)

P-No.	Grp. No.	Spec. No.	Type, Grade, or UNS No.
Nickel and Nickel-Base Alloys (Cont'd)			
44		SB-626	N06455
44		SB-626	N10001
44		SB-626	N10276
44		SB-626	N10665
44		SB-626	N10675
45		SB-163	N08800
45		SB-163	N08810
45		SB-163	N08811
45		SB-163	N08825
45		SA-351	CN3MN
45		SA-351	N08007
45		SA-351	N08151
45		SB-366	N06007
45		SB-366	N06030
45		SB-366	N06985
45		SB-366	N08020
45		SB-366	N08800
45		SB-366	N08825
45		SB-366	N08925
45		SB-407	N08800
45		SB-407	N08810
45		SB-407	N08811
45		SB-408	N08800
45		SB-408	N08810
45		SB-408	N08811
45		SB-409	N08800
45		SB-409	N08810
45		SB-409	N08811
45		SB-423	N08825
45		SB-424	N08825
45		SB-425	N08825
45		SB-435	R30556
45		SB-462	N08020
45		SB-462	N08367
45		SB-463	N08020
45		SB-463	N08024
45		SB-463	N08026
45		SB-464	N08020
45		SB-464	N08024
45		SB-464	N08026
45		SB-468	N08020
45		SB-468	N08024
45		SB-468	N08026
45		SB-473	N08020
45		SB-514	N08800
45		SB-514	N08810
45		SB-515	N08800
45		SB-515	N08810
45		SB-515	N08811
45		SB-564	N08367
45		SB-564	N08800
45		SB-564	N08810
45		SB-564	N08811
45		SB-572	R30556
45		SB-581	N06007
45		SB-581	N06030
45		SB-581	N06975
45		SB-581	N06985
45		SB-582	N06007
45		SB-582	N06030
45		SB-582	N06975
45		SB-582	N06985
45		SB-599	N08700
45		SB-619	N06007
45		SB-619	N06030
45		SB-619	N06975
45		SB-619	N06985
45		SB-619	N08320
45		SB-619	R30556
45		SB-620	N08320
45		SB-621	N08320
45		SB-622	N06007
45		SB-622	N06030
45		SB-622	N06975
45		SB-622	N06985
45		SB-622	N08320
45		SB-622	R30556
45		SB-625	N08904
45		SB-625	N08925
45		SB-626	N06007
45		SB-626	N06030
45		SB-626	N06975
45		SB-626	N06985
45		SB-626	N08320
45		SB-626	R30556
45		SB-649	N08904
45		SB-649	N08925
45		SB-668	N08028
45		SB-672	N08700
45		SB-673	N08904
45		SB-673	N08925
45		SB-674	N08904
45		SB-674	N08925
45		SB-675	N08366

APPENDIX D — NONMANDATORY P-NUMBER LISTING (CONT'D)

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P-No.	Grp. No.	Spec. No.	Type, Grade, or UNS No.
Nickel and Nickel-Base Alloys (Cont'd)			
45		SB-675	N08367
45		SB-676	N08366
45		SB-676	N08367
45		SB-677	N08904
45		SB-677	N08925
45		SB-688	N08366
45		SB-688	N08367
45		SB-690	N08366
45		SB-690	N08367
45		SB-691	N08366
45		SB-691	N08367
45		SB-704	N08825
45		SB-705	N08825
45		SB-709	N08028
45		SB-729	N08020
46		SB-366	N08330
46		SB-511	N08330
46		SB-535	N08330
46		SB-536	N08330
46		SB-710	N08330
47		SB-366	N06230
47		SB-435	N06230
47		SB-564	N06230
47		SB-572	N06230
47		SB-619	N06230
47		SB-622	N06230
47		SB-626	N06230
Titanium and Titanium-Base Alloys			
51		SB-265	R50250
51		SB-265	R50400
51		SB-265	R52250
51		SB-265	R52252
51		SB-265	R52400
51		SB-265	R52402
51		SB-337	R50250
51		SB-337	R50400
51		SB-337	R52400
51		SB-338	R50250
51		SB-338	R50400
51		SB-338	R52400
51		SB-338	R52402
51		SB-348	R50250

P-No.	Grp. No.	Spec. No.	Type, Grade, or UNS No.
Titanium and Titanium-Base Alloys (Cont'd)			
51		SB-348	R50400
51		SB-348	R50402
51		SB-348	R52400
51		SB-363	R50250
51		SB-363	R50400
51		SB-363	R52400
51		SB-367	R50400
51		SB-381	R50250
51		SB-381	R50400
51		SB-381	R50402
51		SB-381	R52400
52		SB-265	R50550
52		SB-265	R53400
52		SB-337	R50550
52		SB-337	R53400
52		SB-338	R50550
52		SB-338	R53400
52		SB-348	R50550
52		SB-348	R53400
52		SB-363	R50550
52		SB-363	R53400
52		SB-367	R50550
52		SB-381	R50550
52		SB-381	R53400
53		SB-265	R56320
53		SB-337	R56320
53		SB-338	R56320
53		SB-348	R56320
53		SB-363	R56320
53		SB-381	R56320
Zirconium and Zirconium-Base Alloys			
61		SB-493	R60702
61		SB-523	R60702
61		SB-550	R60702
61		SB-551	R60702
61		SB-658	R60702
62		SB-493	R60705
62		SB-523	R60705
62		SB-550	R60705
62		SB-551	R60705
62		SB-658	R60705

APPENDIX E—MANDATORY PERMITTED SWPSs

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The following Standard Welding Procedure Specifications may be used under the conditions given in Article V.

Specification	Designation
Carbon Steel	
Shielded Metal Arc Welding	
Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, E7018, As-Welded or PWHT Condition	B2.1-1-016-94
Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, E6010, As-Welded or PWHT Condition	B2.1-1-017-94
Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, E6010 (Vertical Uphill) Followed by E7018, As-Welded or PWHT Condition	B2.1-1-022-94
Standard Welding Procedure Specification for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, E6010 (Vertical Downhill) Followed by E7018, As-Welded or PWHT Condition	B2.1-1-026-94
Combination GTAW and SMAW	
Standard Welding Procedure Specification for Gas Tungsten Arc Welding Followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, ER70S-2 and E7018, As-Welded or PWHT Condition	B2.1-1-021-94
Carbon Steel — Primarily Pipe Applications	
Shielded Metal Arc Welding	
Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $\frac{3}{4}$ inch Thick, E6010 (Vertical Uphill) Followed by E7018 (Vertical Uphill), As-Welded Condition, Primarily Pipe Applications	B2.1-1-201-96
Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $\frac{3}{4}$ inch Thick, E6010 (Vertical Downhill) Followed by E7018 (Vertical Uphill), As-Welded Condition, Primarily Pipe Applications	B2.1-1-202-96
Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $\frac{3}{4}$ inch Thick, E6010 (Vertical Uphill), As-Welded Condition, Primarily Pipe Applications	B2.1-1-203-96
Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $\frac{3}{4}$ inch Thick, E6010 (Vertical Downhill Root with the Balance Vertical Uphill), As-Welded Condition, Primarily Pipe Applications	B2.1-1-204-96
Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, E6010 (Vertical Uphill) Followed by E7018 (Vertical Uphill), As-Welded or PWHT Condition, Primarily Pipe Applications	B2.1-1-205-96

Specification	Designation
Carbon Steel — Primarily Pipe Applications (cont'd)	
Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, E6010 (Vertical Downhill) Followed by E7018 (Vertical Uphill), As-Welded or PWHT Condition, Primarily Pipe Applications	B2.1-1-206-96
Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, E7018, As-Welded or PWHT Condition, Primarily Pipe Applications	B2.1-1-208-96
Gas Tungsten Arc Welding	
Standard Welding Procedure Specification (WPS) for Gas Tungsten Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, ER70S-2, As-Welded or PWHT Condition, Primarily Pipe Applications	B2.1-1-207-96
Combination GTAW and SMAW	
Standard Welding Procedure Specification (WPS) for Gas Tungsten Arc Welding Followed by Shielded Metal Arc Welding of Carbon Steel (M-1/P-1/S-1, Group 1 or 2), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, ER70S-2 and E7018, As-Welded or PWHT Condition, Primarily Pipe Applications	B2.1-1-209-96
Austenitic Stainless Steel Plate and Pipe	
Shielded Metal Arc Welding	
Standard Welding Procedure Specification for Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, As-Welded Condition	B2.1-1-023-94
Austenitic Stainless Steel Primarily Pipe Applications	
Shielded Metal Arc Welding	
Standard Welding Procedure Specification (WPS) for Shielded Metal Arc Welding of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, E3XX-XX, As-Welded Condition	B2.1-8-213-97
Gas Tungsten Arc Welding	
Standard Welding Procedure Specification (WPS) for Gas Tungsten Arc Welding, with Consumable Insert of Austenitic Stainless Steel (M-8/P-8/S-8, Group 1), $\frac{1}{8}$ through $1\frac{1}{2}$ inch Thick, IN3XX and ER3XX, As-Welded Condition	B2.1-8-215-98